

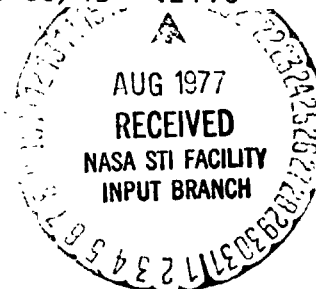
Part 1 of 4

VIBRATION POWER SPECTRAL DENSITY ANALYSIS OF LAUNCH AND MAX Q FLIGHT

[NASA-CR-144945-Pt-1) A COMPILATION OF SPACECRAFT LOADS DATA FROM FOUR TITAN CENTAUR LAUNCH VEHICLE FLIGHTS. VOLUME 2, PART 1: VIBBATION POWER SPECTRAL DENSITY ANALYSIS OF LAUNCH AND MAX Q FLIGHT (General G3/15

N77-28182

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42476



for

January 1977

1. Report No. NASA CR-144945-1		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle A Compilation of Spacecraft Loads Data From Four Titan Centaur Launch Vehicle Flights Volume II - PSD Analyses of Launch & Max Q				5. Report Date January 1977	
				6. Performing Organization Code	
7. Author(s) George Kachadourian				8. Performing Organization Report No.	
9. Performing Organization Name and Address General Electric Company Viking Program Support Services 17 Research Road, Hampton, Va. 23666				10. Work Unit No.	
				11. Contract or Grant No. NAS1-9100	
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Langley Research Center, Hampton, Va. 23665				13. Type of Report and Period Covered Contractor Report	
				14. Sponsoring Agency Code	
15. Supplementary Notes This report is a compilation of PSD analyses processed by the Langley Research Center Analysis and Computation Division under the direction of the Viking Project Office.					
16. Abstract The payloads carried by the first four Titan Centaur Launch Vehicle flights were a Viking Dynamic Simulator, the Helios A Spacecraft and the two Viking Spacecraft. Dynamic loads data were gathered by the NASA Viking Project Office from these four flights for applications to the Viking Spacecraft. This volume contains time histories and Power Spectral Density (PSD) analyses of vibration and acceleration measurements on the spacecraft from the 1st, 3rd and 4th Titan Centaur launchings, TC-1, TC-4 and TC-3 respectively. Summary plots are also presented.					
17. Key Words (Suggested by Author(s)) Viking Spacecraft, Titan Centaur Vibration Environment Power Spectral Density				18. Distribution Statement Unclassified	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price*		

A COMPILATION OF SPACECRAFT LOADS DATA
FROM
FOUR TITAN CENTAUR LAUNCH VEHICLE FLIGHTS
VOLUME II
VIBRATION POWER SPECTRAL DENSITY ANALYSES
LAUNCH AND MAX Q FLIGHT

ABSTRACT

The payloads carried by the first four Titan Centaur Launch Vehicle Flights were, a Viking Spacecraft Dynamic Simulator, the Helios-1 Spacecraft and the two Viking Spacecraft. A wealth of dynamic loads data was accumulated by the NASA Viking Project Office from these four flights for application to the Viking Spacecraft. This report contains a compilation of that data and is presented for reference and information. The data has been compiled into the following five Volumes:

- Volume I - Acoustic Data (NASA CR-144944)
- Volume II - Vibration Power Spectral Density Data (NASA CR-144945)
- Volume III - Shock Spectra of Transients (NASA CR-144946)
- Volume IV - Titan Stage I and Centaur Burn Oscillation (NASA CR-144947)
- Volume V - Time History Plots (NASA CR-144948)

Contents of Volume II

- 1 - Summary Data
- 2 - TC-1 Launch with Viking Dynamic Simulator
- 3 - TC-4 Launch with Viking A Spacecraft
- 4 - TC-3 Launch with Viking B Spacecraft

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Notations Used in Volume II

Bus -	Major structural assembly of Viking Orbiter - see Figure 3.1
Max Q -	Period of launch flight of maximum dynamic pressure
PSD -	Power spectral density, vibration, g^2 /Hertz
VDS -	Viking Dynamic Simulator, TC-1 payload
VLC -	Viking Lander Capsule
VLCA -	Viking Lander Capsule Adapter
VO -	Viking Orbiter
VS/C -	Viking Spacecraft
V-S/C-A-	Viking Spacecraft Adapter
TC-1 -	The Titan Centaur Launch Vehicle Number 1
TC-2 -	The Titan Centaur Launch Vehicle Number 2, Helios Spacecraft
TC-3 -	The Titan Centaur Launch Vehicle Number 3, Second Viking Spacecraft Launch
TC-4 -	The Titan Centaur Launch Vehicle Number 4, First Viking Spacecraft Launch

VOLUME II

VIBRATION PSD OF LAUNCH AND MAX Q FLIGHT DATA

SECTION I

SUMMARY DATA

Volume II presents Power Spectral Density analyses of vibration measurements made on the spacecraft section of the first, third and fourth launch flights of the Titan Centaur Launch Vehicles. The spacecraft carried were the Viking Dynamic Simulator (VDS), and the first and second Viking Spacecraft. The data is for two locations on the spacecraft: (1) the center of gravity of the Viking Lander Capsule, and (2) several points on the Viking Orbiter Bus. The Viking Lander Capsule c.g. data was obtained through transformations of adapter strain gage measurements and contains data in the 0-40 Hertz frequency band. The Bus data is from both crystal and servo accelerometers and provides data in the 0-2000 Hertz range. The Bus is the primary structural assembly of the Viking Orbiter and the data is more representative of structure response rather than component response. All of the data was telemetered on IRIG Proportional Subcarrier Bands, however nonstandard filtering was used in playback to enhance the frequency content of the data.

Volume II is contained in four sections.

Section 1 summarizes all of the data into composite and envelope PSD plots.

Section 2 contains individual PSD plots and associated time histories from the first launch, carrying the Viking Dynamic Simulator.

Section 3 and 4 contain the individual data from the two Viking Spacecraft.

Measurement locations, telemetry channel assignments, filter usage and measurement identification notations are contained in Sections 2, 3 and 4 with the respective spacecraft.

All of the data processing contained in this report was performed at the Langley Research Center by the Analysis and Computations Division and their contractors. The computer program used for the PSD is the NASA Langley Signal Analysis Program (Reference 1). The program uses Blackman-Tukey-Fast Fourier Transform techniques.

Reference 1. Keisler, S. R., Langley Signal Analysis Program.
NASA CR- (to be published)

POWER SPECTRAL DENSITY

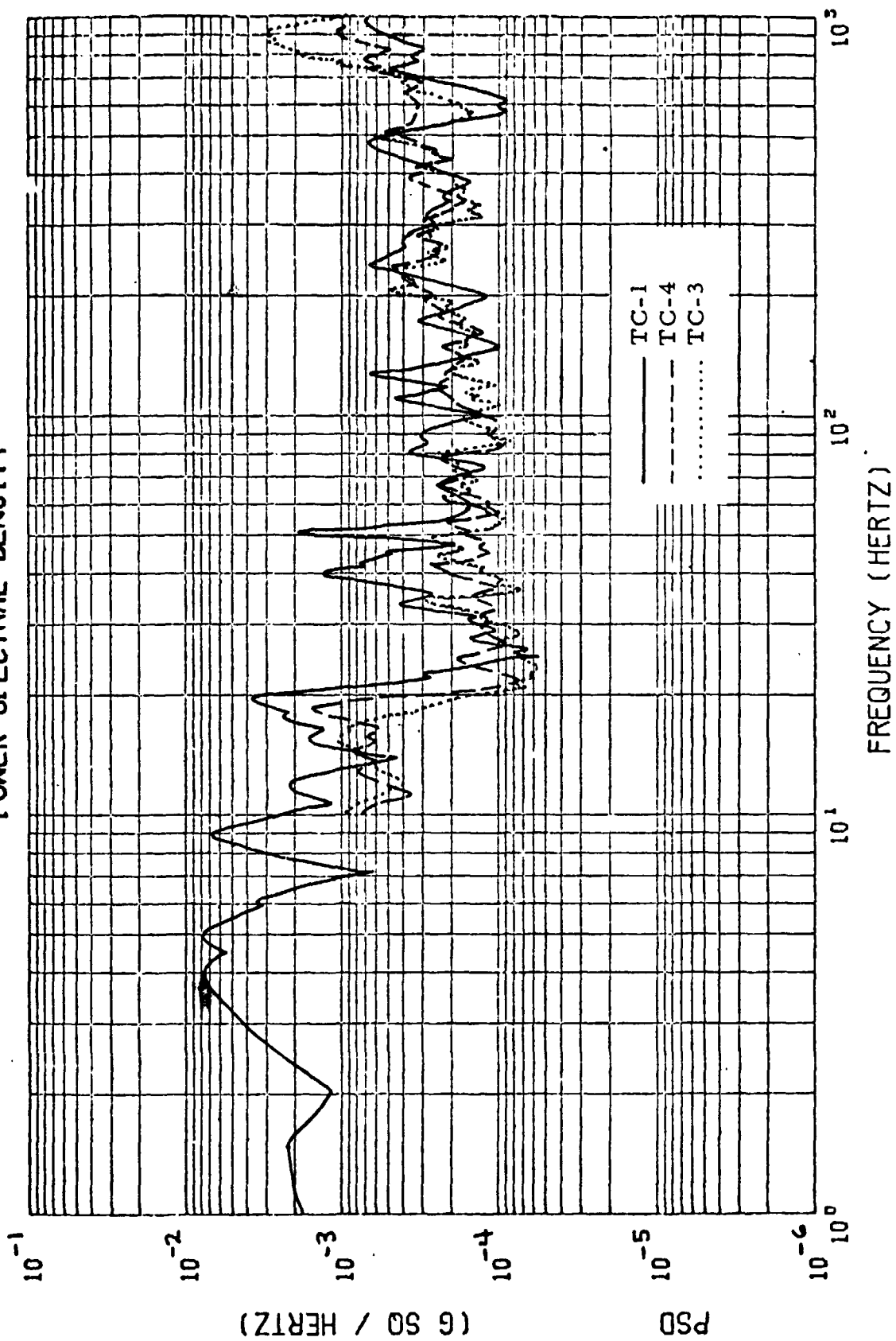


Figure 1.1 Summary of Bus Acceleration PSD's

POWER SPECTRAL DENSITY

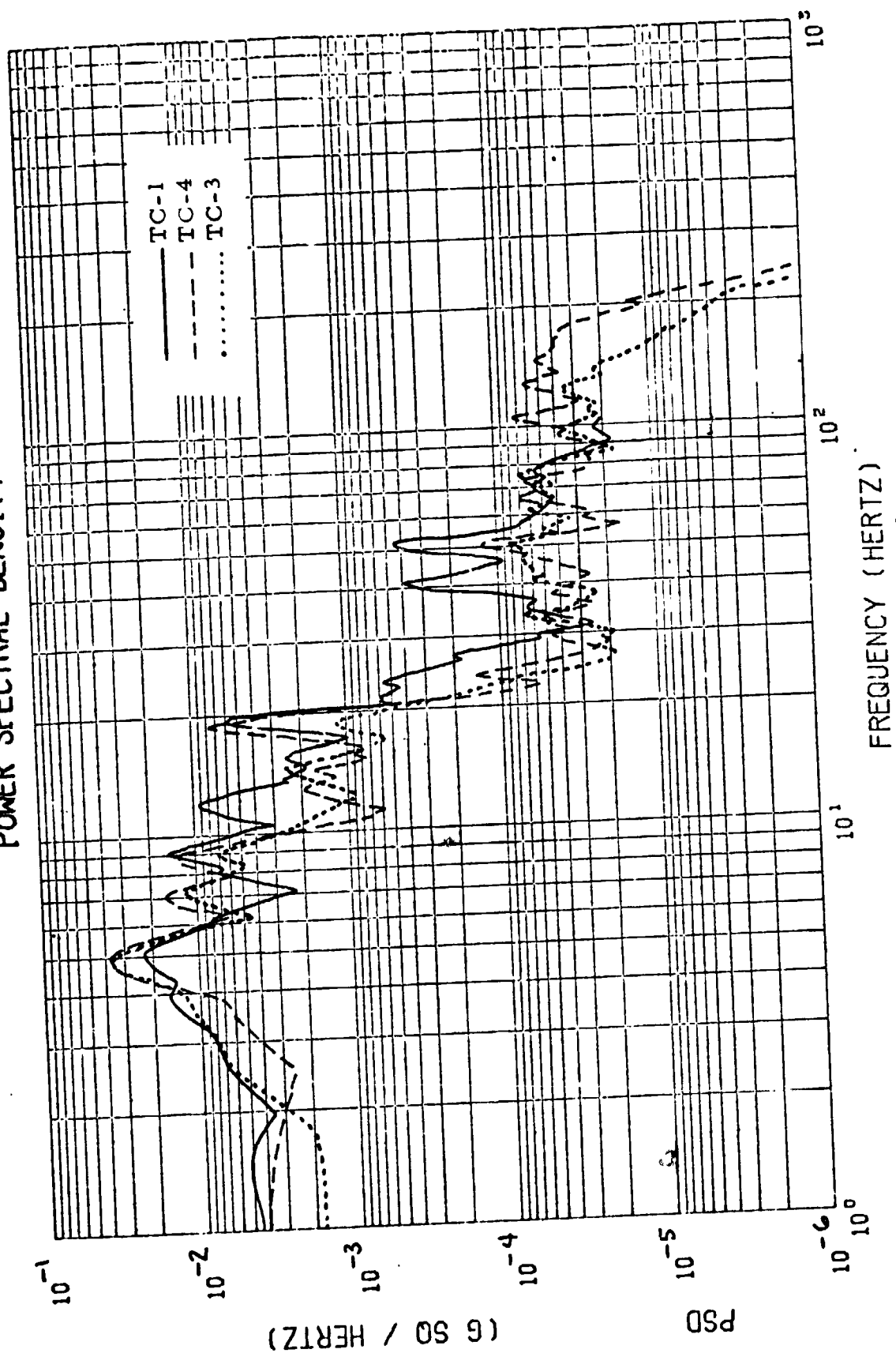


Figure 1.2 Summary of VLC CG Acceleration PSD's

POWER SPECTRAL DENSITY

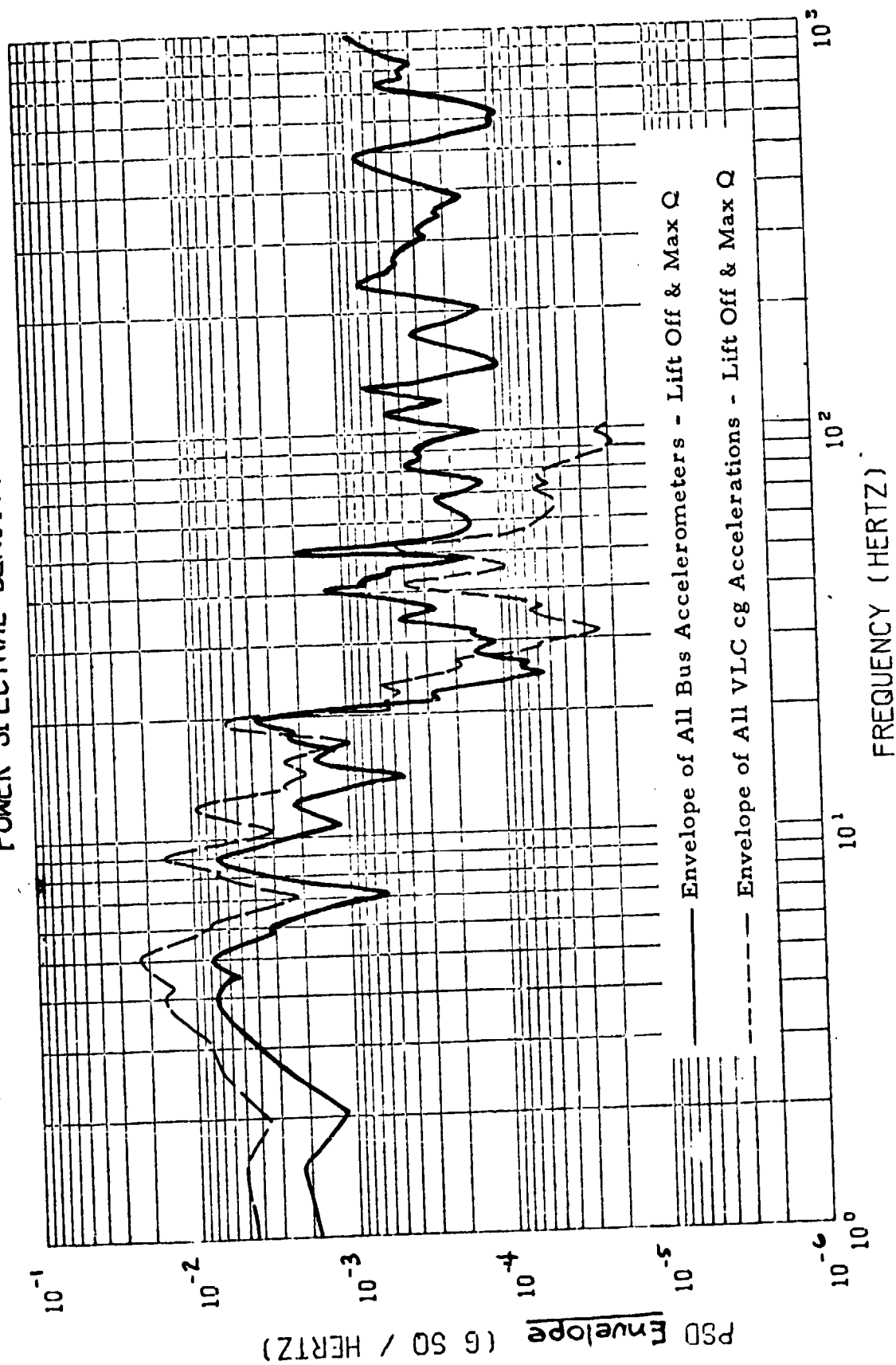
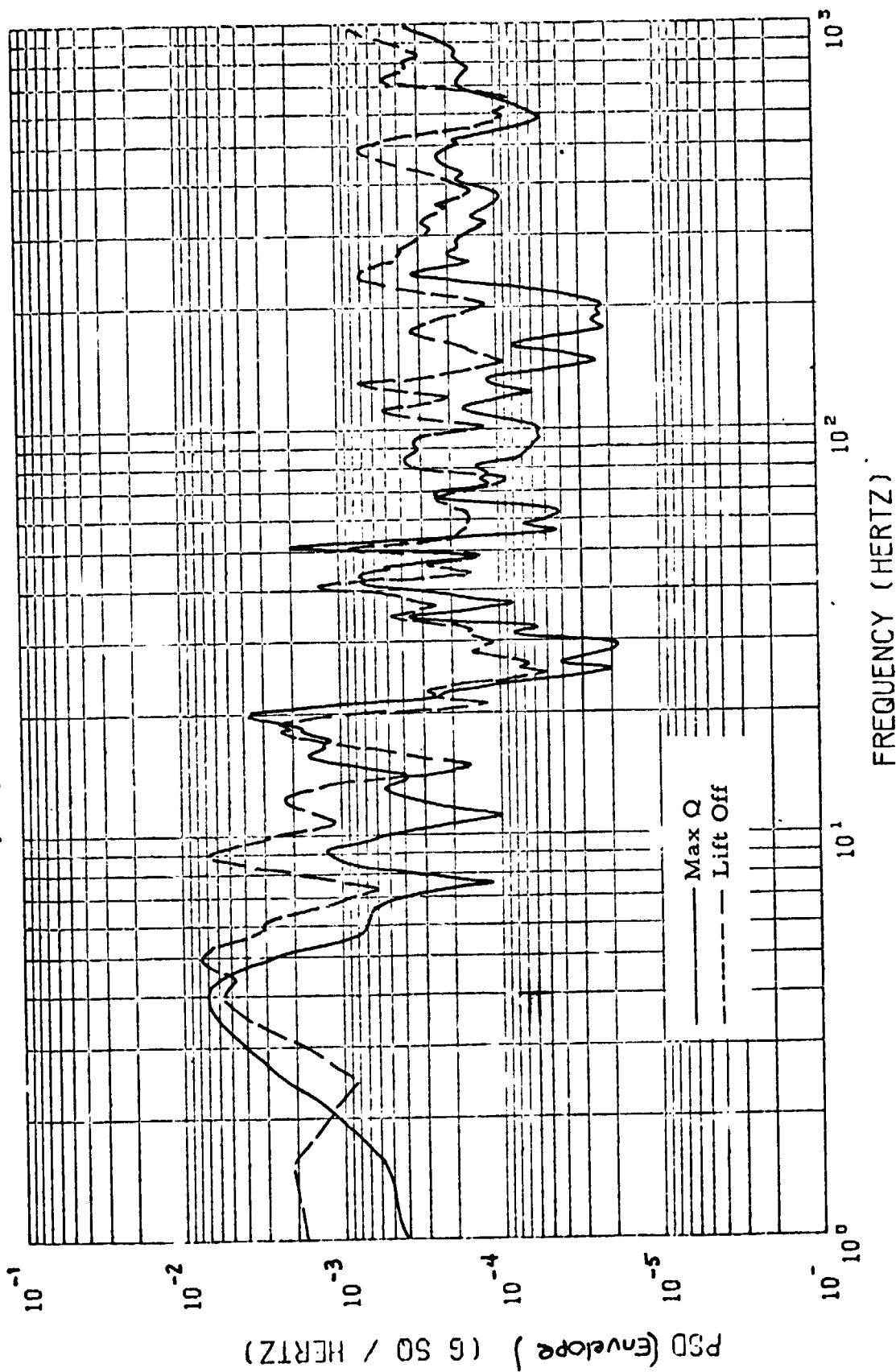


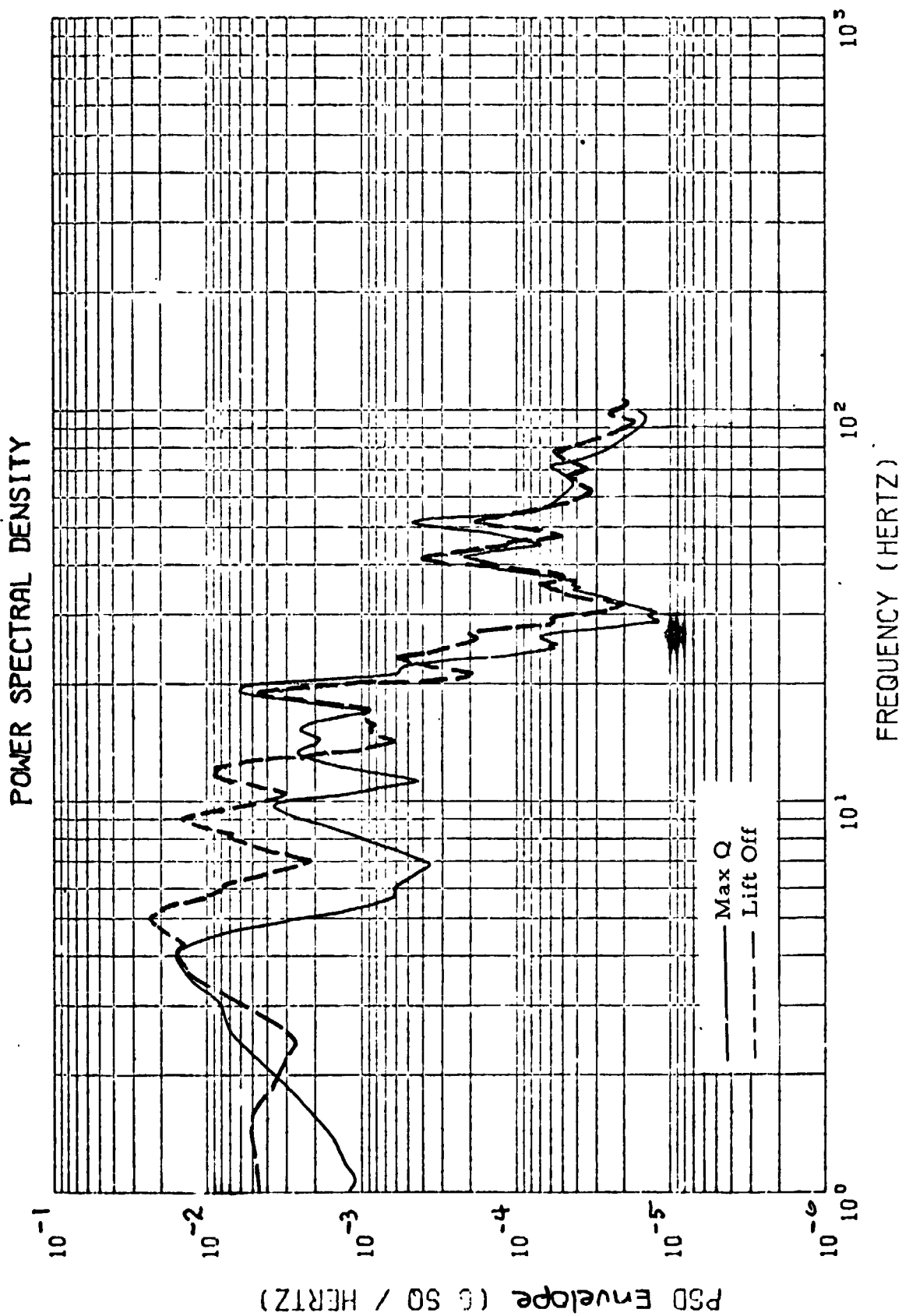
Figure 1.3 TC-1 VDS PSD Envelopes

POWER SPECTRAL DENSITY



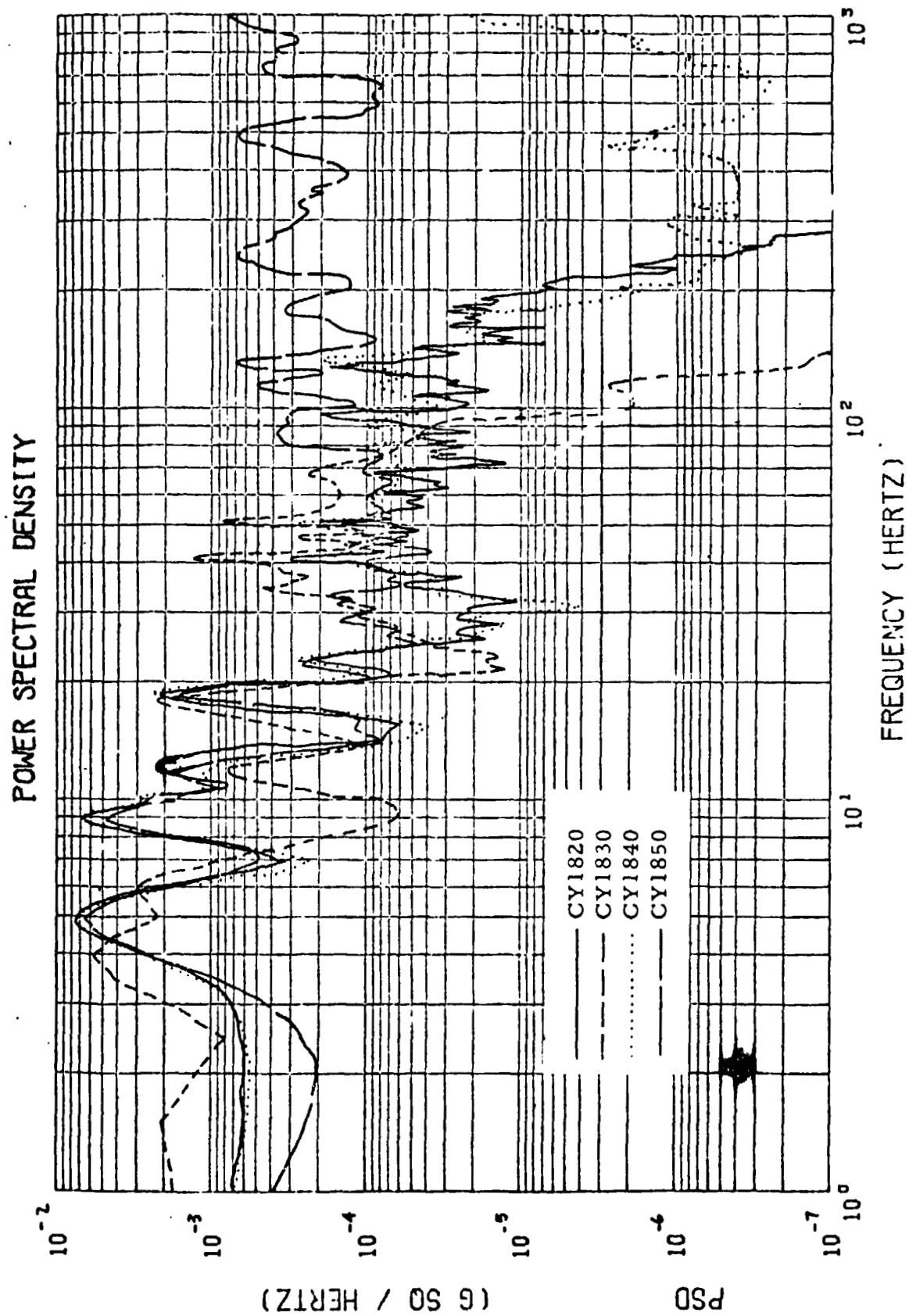
Envelopes of Composite Lift Off & Composite Max Q

Figure 1.4 TC-1 VDS Data - Envelopes of Bus Accelerometers



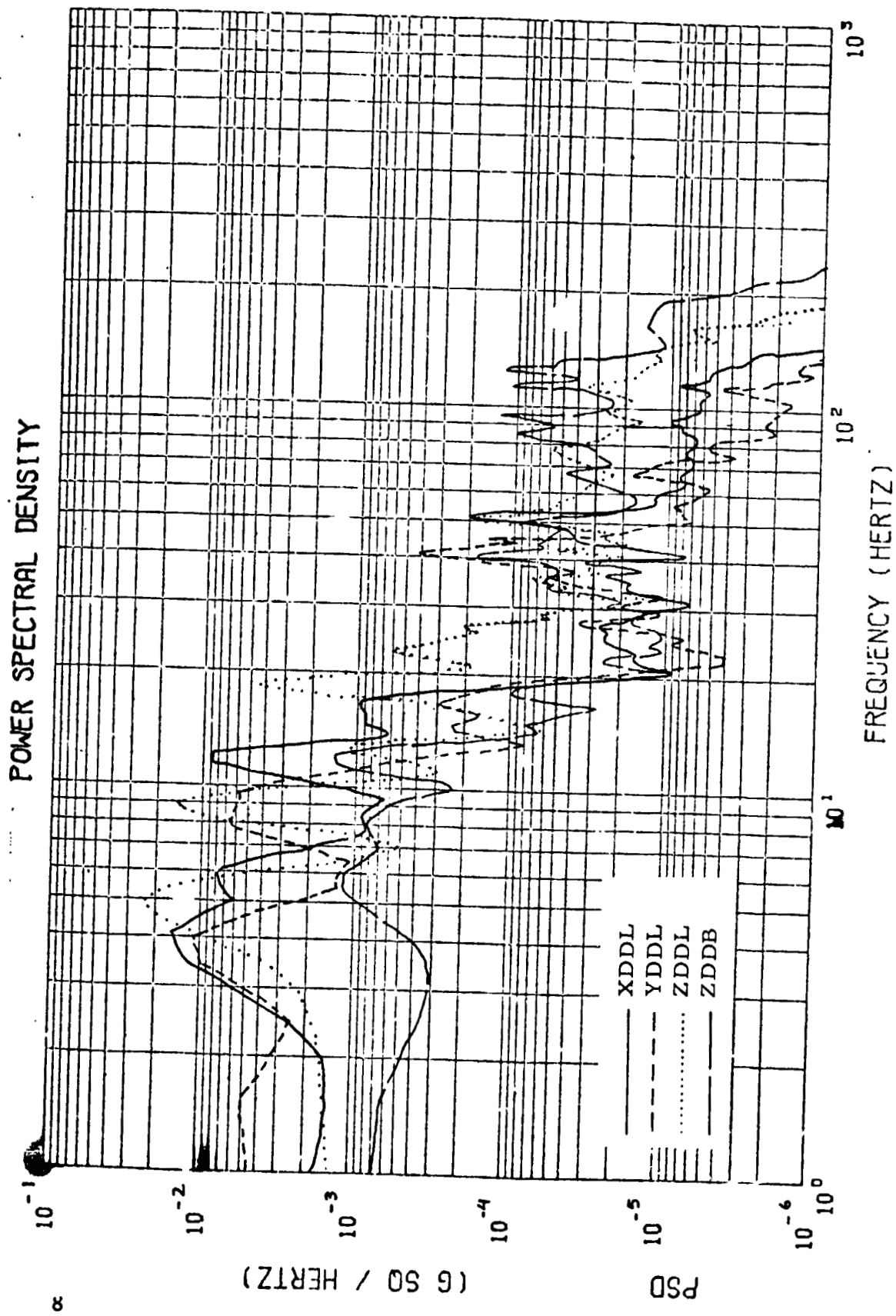
Envelopes of Composite Lift Off and Composite Max Q

Figure 1.5 TC-1 VDS Summary Data of VLC cg Accelerations



TC-1 VDS Summary Data - Bus Accelerometers

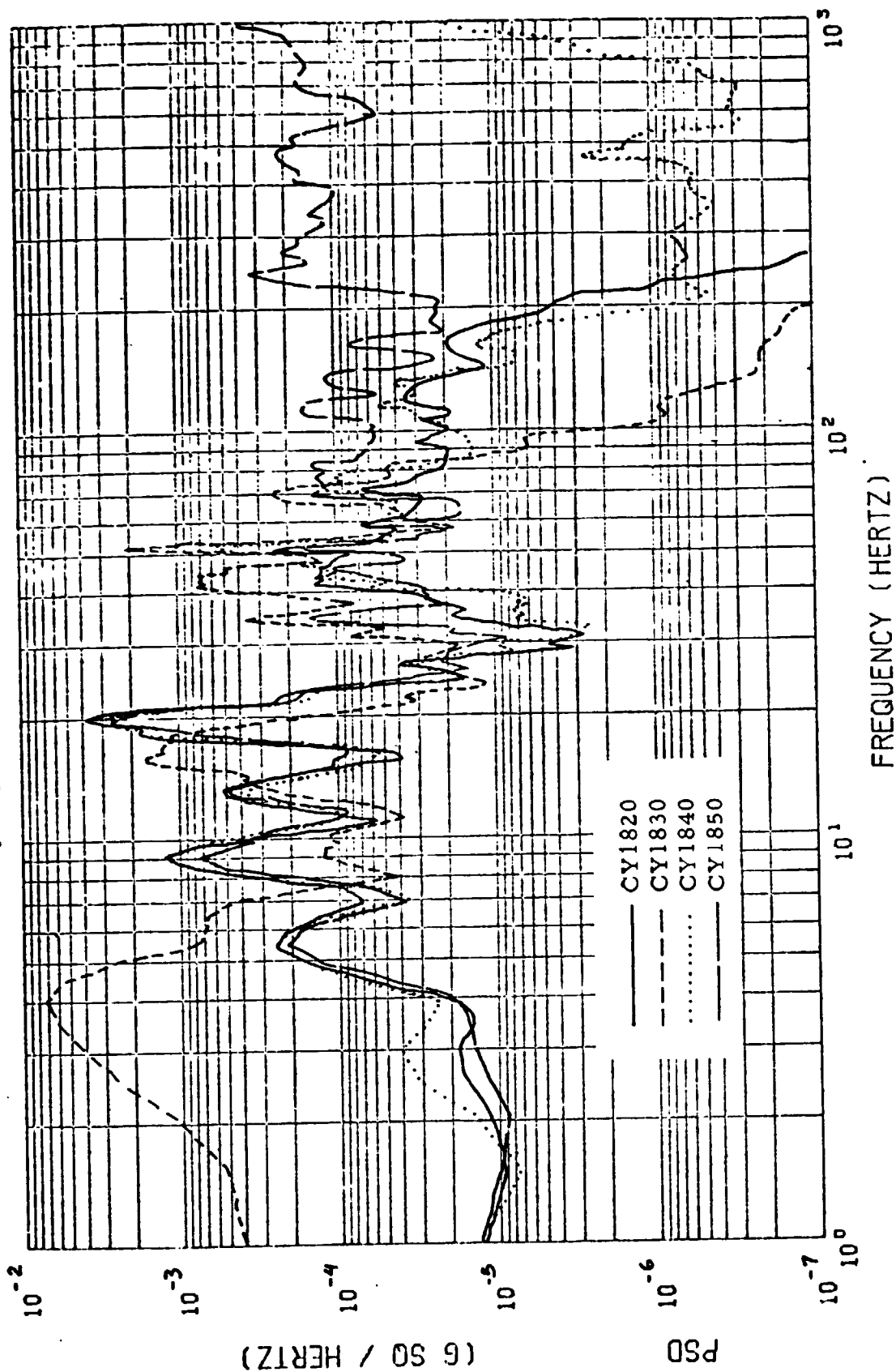
Figure 1.6 Envelopes of Stage 0 Ignition PSD's



TC-1 VDS Summary Data - VLC-cg Acceleration

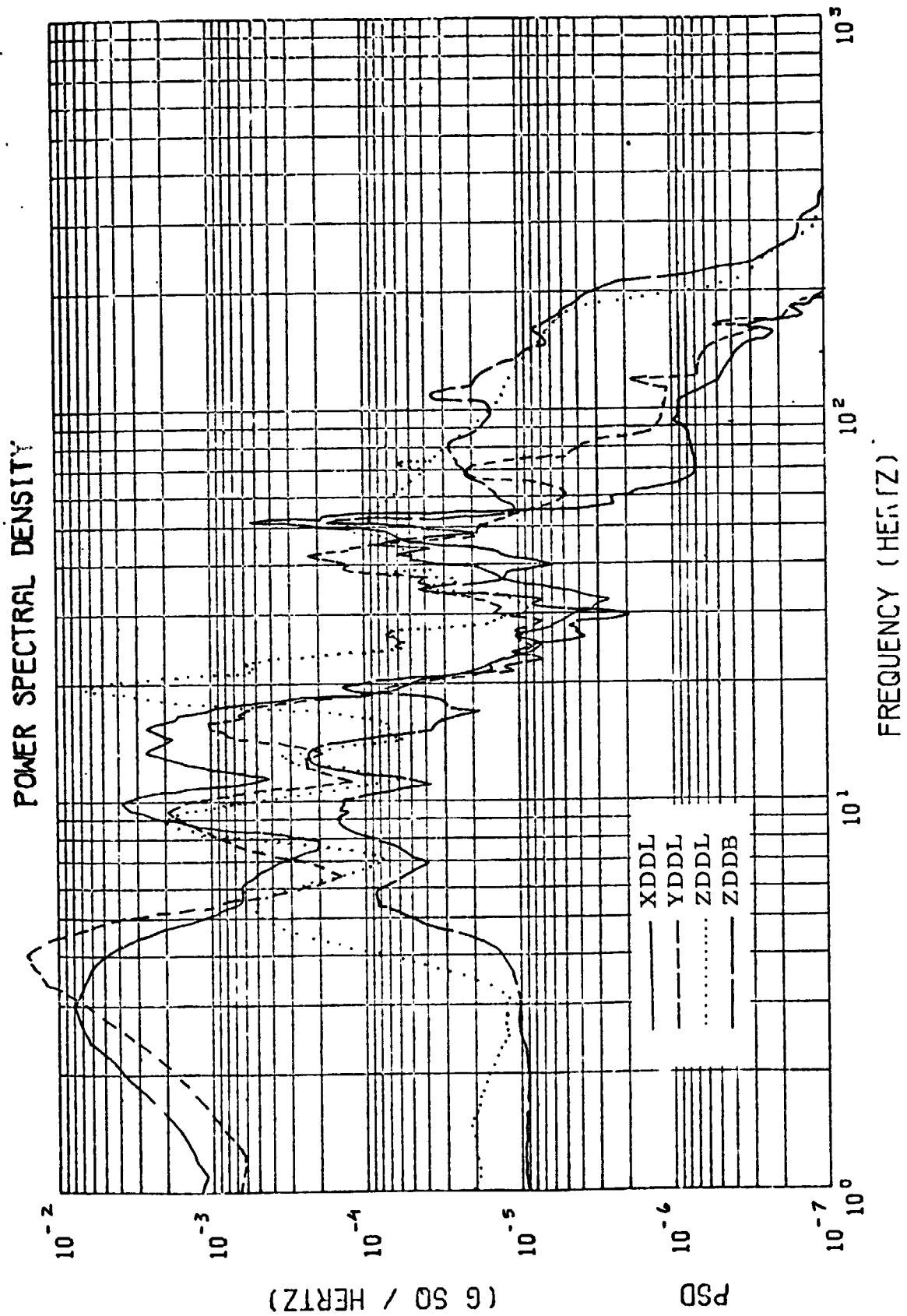
Figure 1.7 Envelopes of Stage 0 Ignition PSD's

POWER SPECTRAL DENSITY



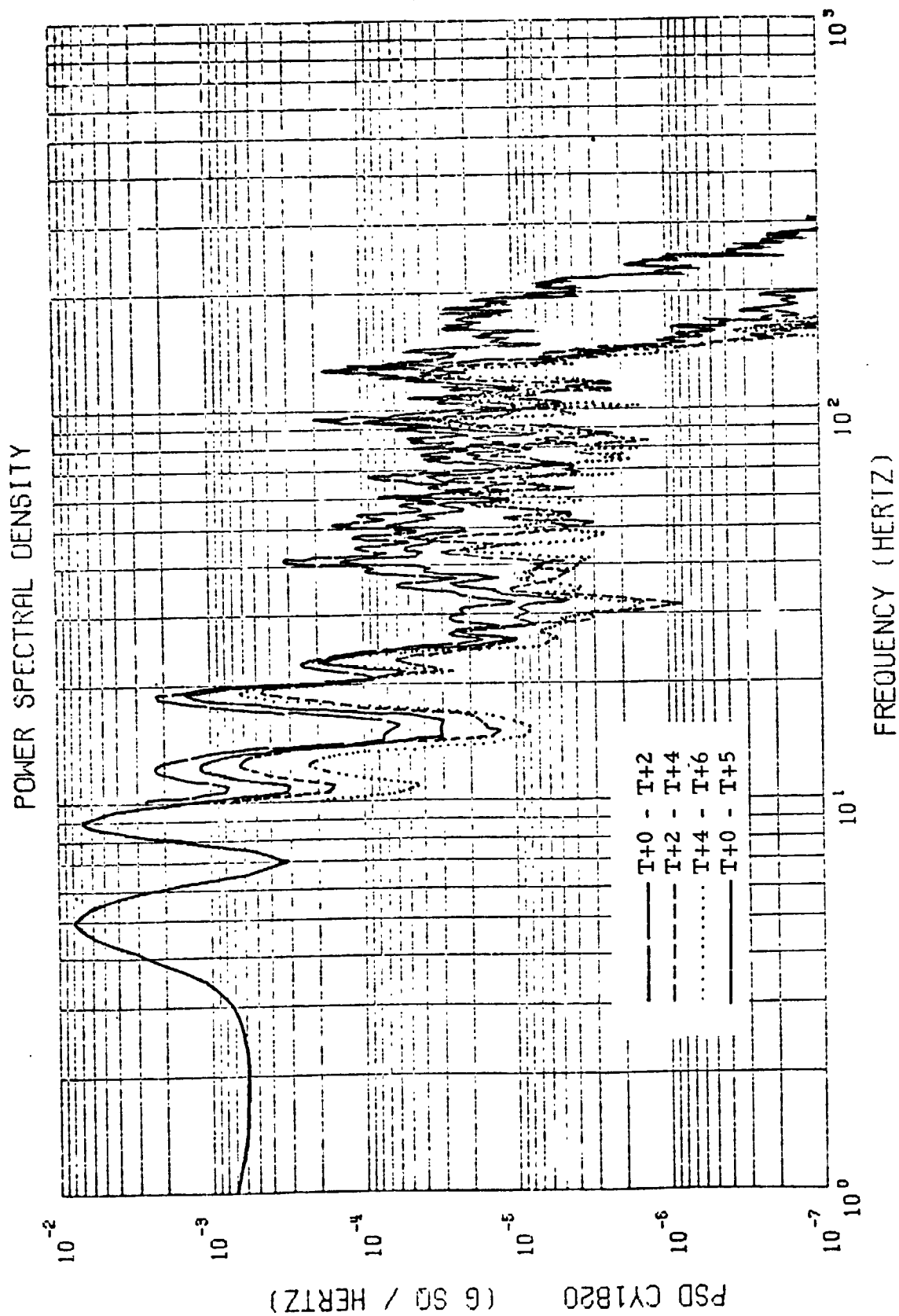
TC-1 VDS Summary Data - Bus Accelerometers

Figure 1.8 Envelopes of Max Q PSD's



TC-1 VDS Summary Data - VLC cg Accelerations

Figure 1.9 Envelopes of Max Q PSD's



11

TC-1 / VDS DATA (LRC-3H)

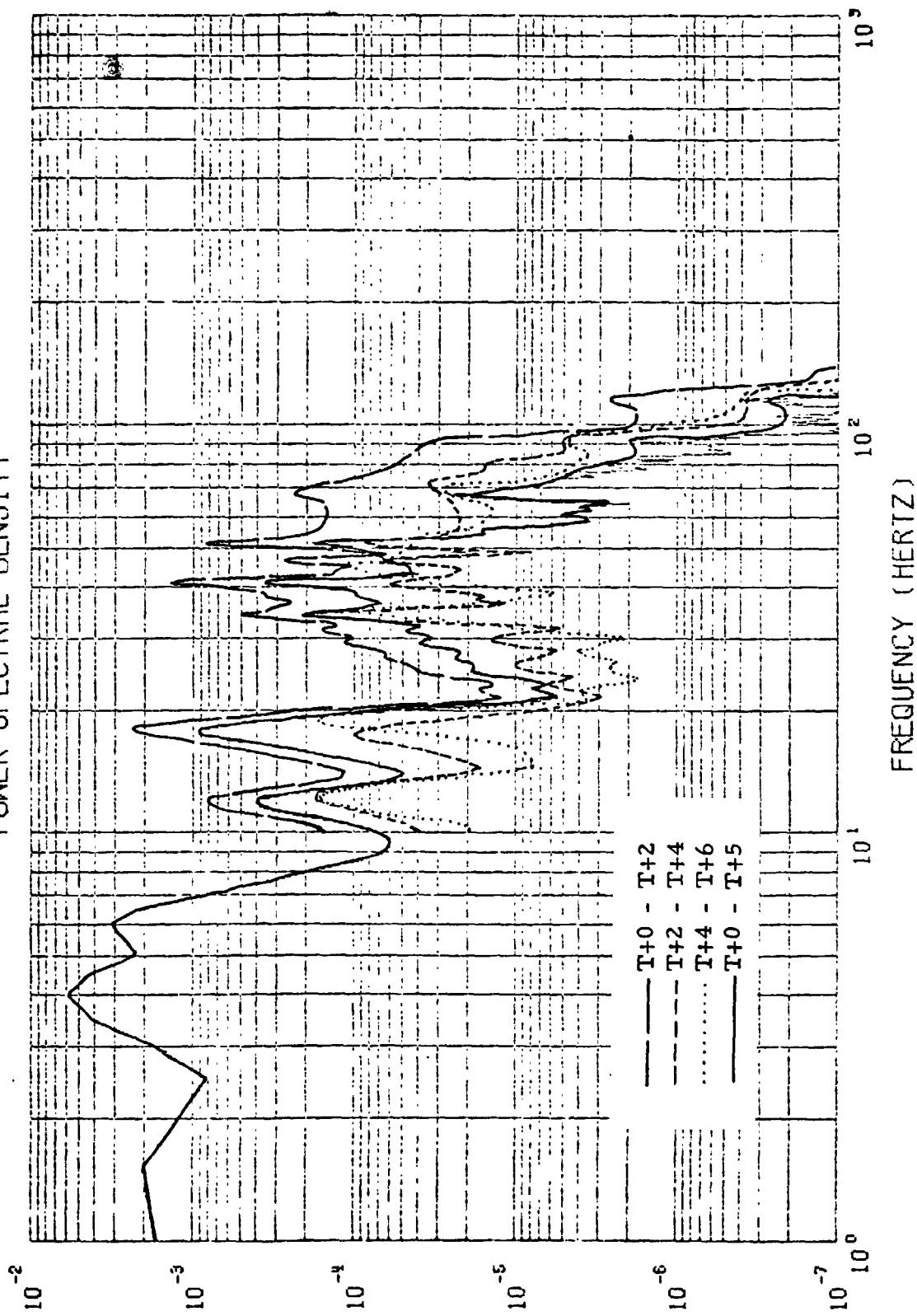
STAGE 0 IGN

CY1820

INSTRUMENT SIGNAL ANALYSIS PROGRAM 07/21/75

Figure 1.10

POWER SPECTRAL DENSITY



$\Delta F = .500$

TC-1 / VDS DATA (LRC-3A)

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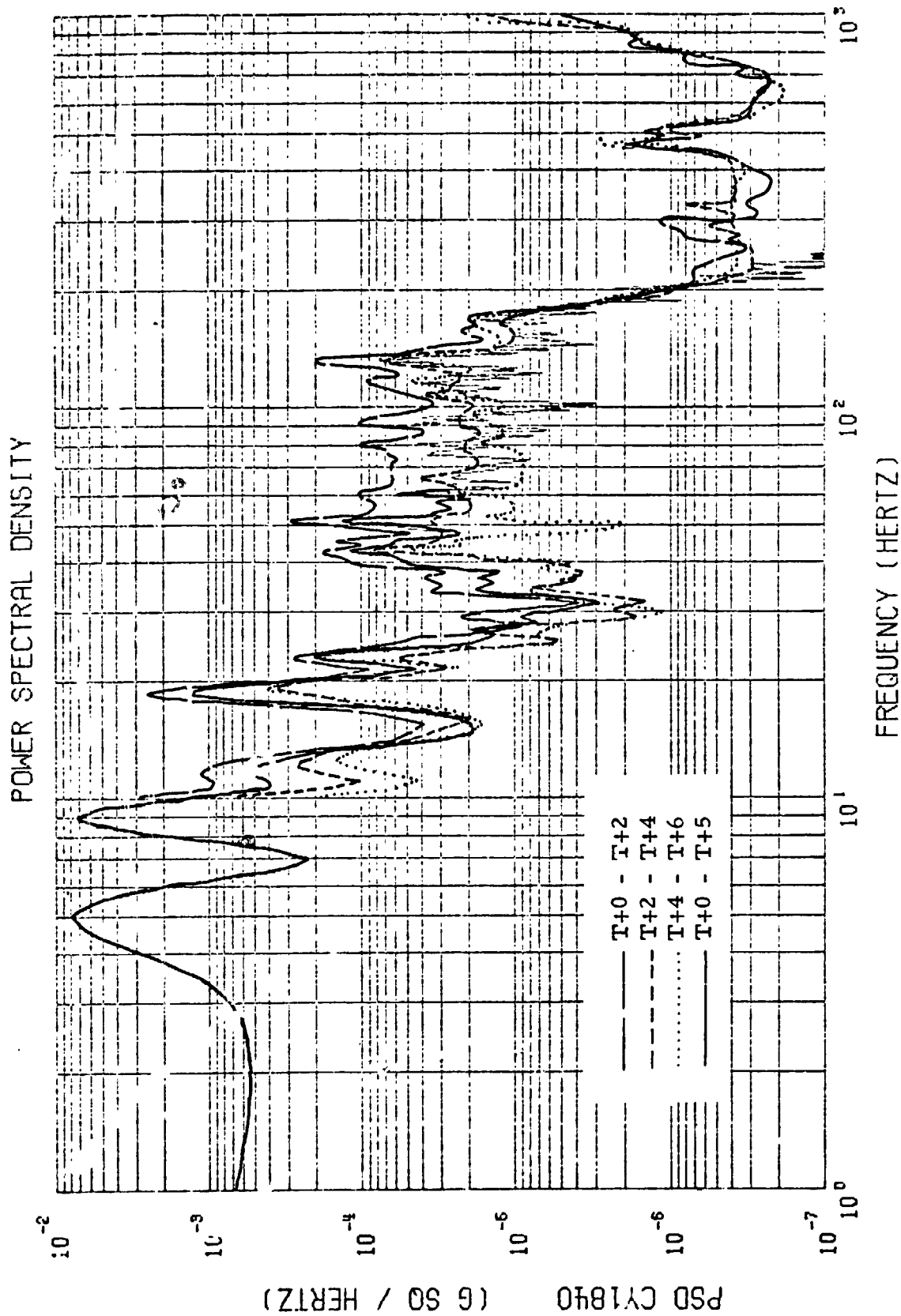
CY1830

WRIGHT-LANGLEY SIGNAL ANALYSIS PROGRAM 07/21/75

Figure 1.11

PSD CY1830 (6 SQ / HERTZ)

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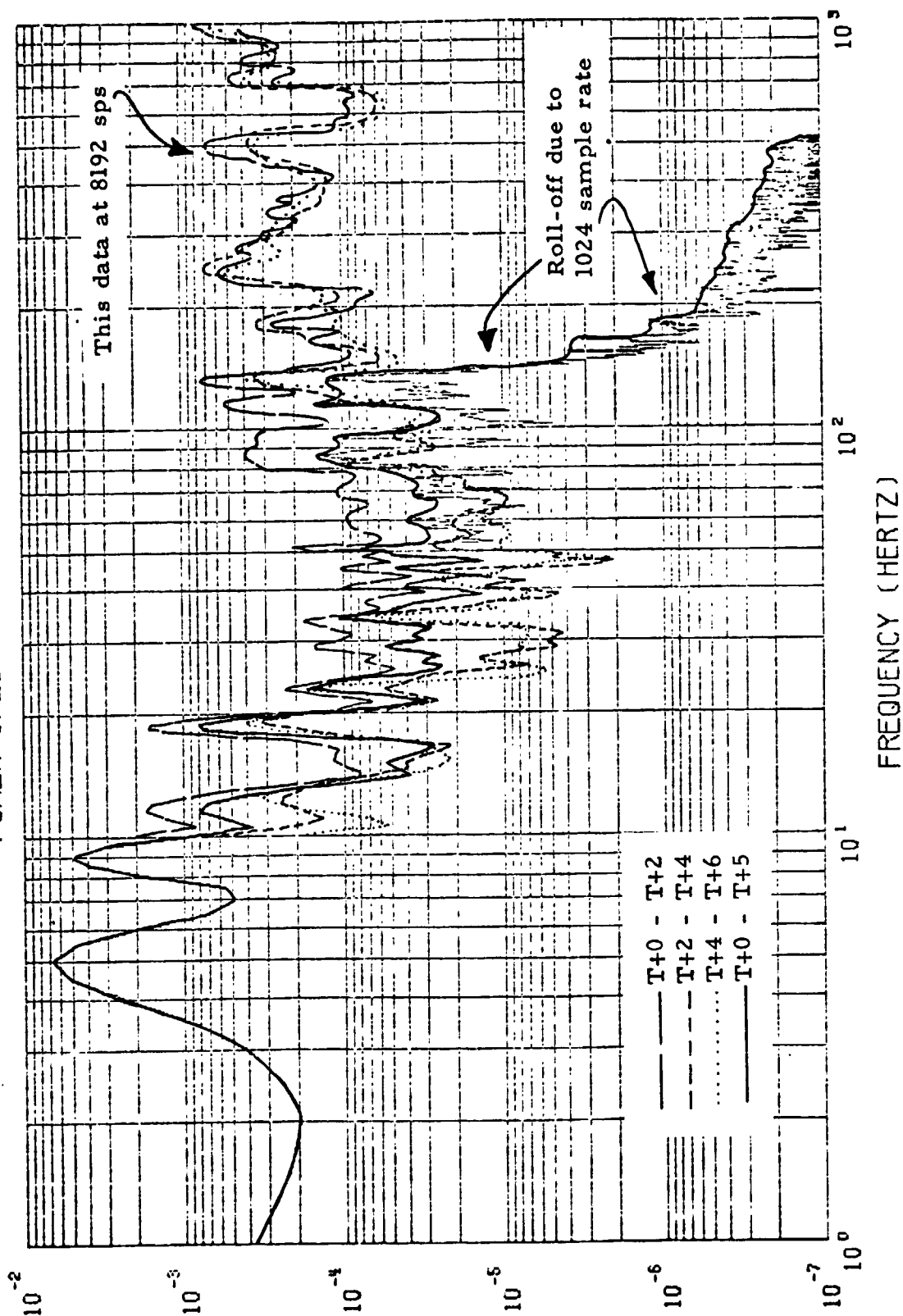
CY1840

STAGE 0 IGN

TC-1 / VDS DATA (LRC-3A)

Figure 1.12

POWER SPECTRAL DENSITY



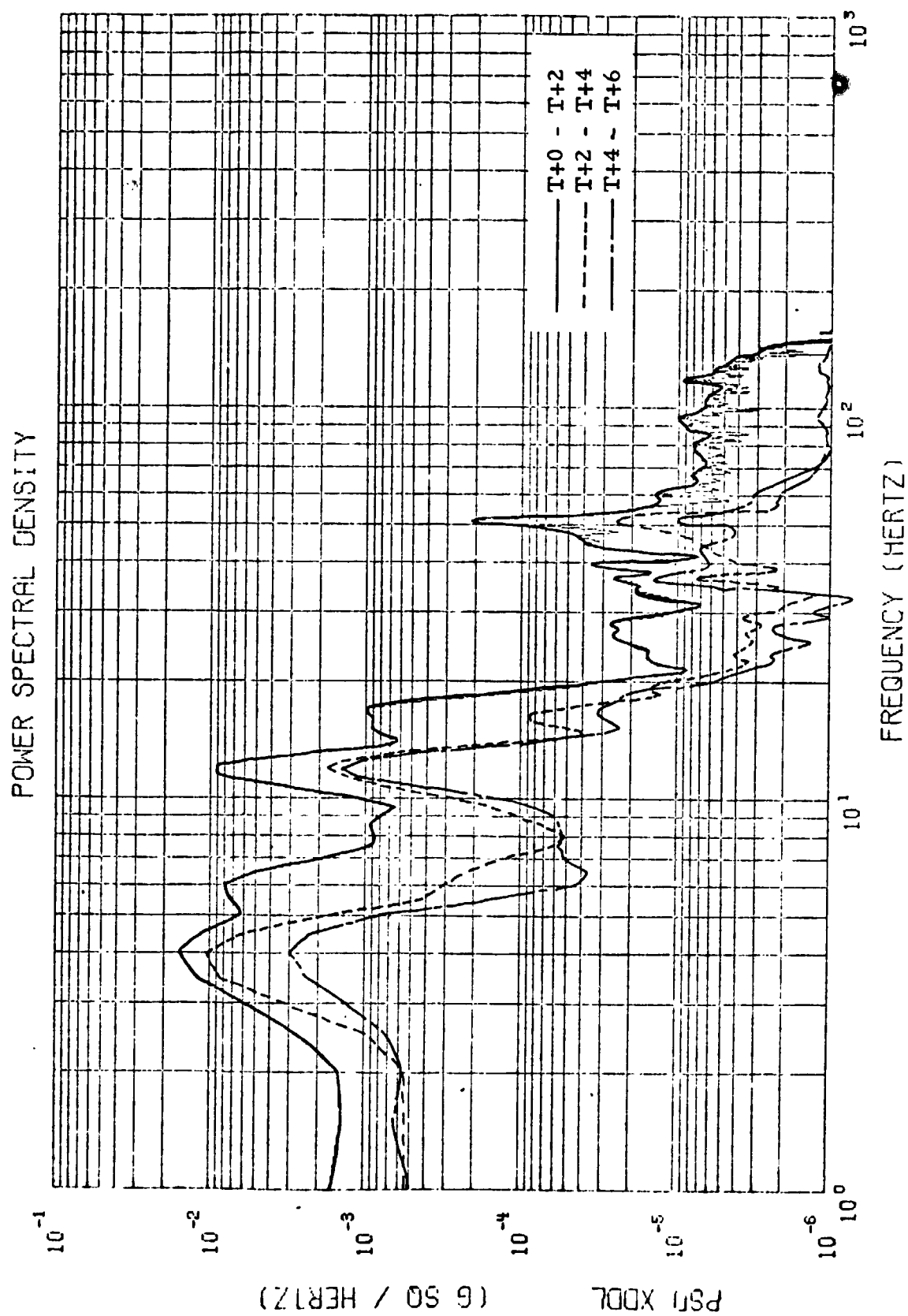
CY1850

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TC-1 / VDS DATA (LRC-3A)

Figure 1.13

WATER TUNNEL STATION ANALYSIS PRINTOUT 07/21/75



TC-1 / VDS DATA (LRC-3A)

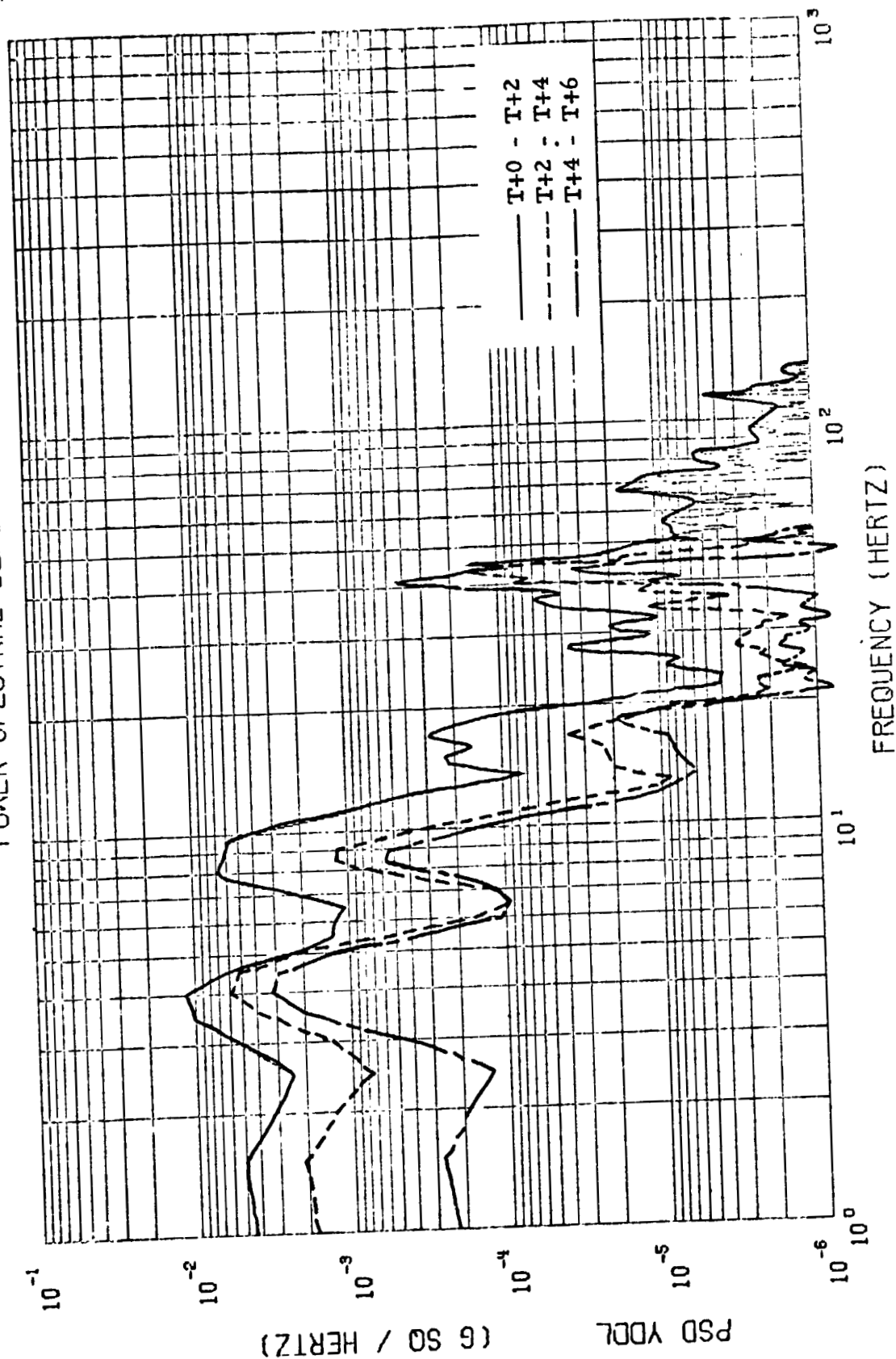
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XDDL

WASA-CORRELEY SIGNAL ANALYSIS PROGRAM 07/23/75

Figure 1.14

POWER SPECTRAL DENSITY



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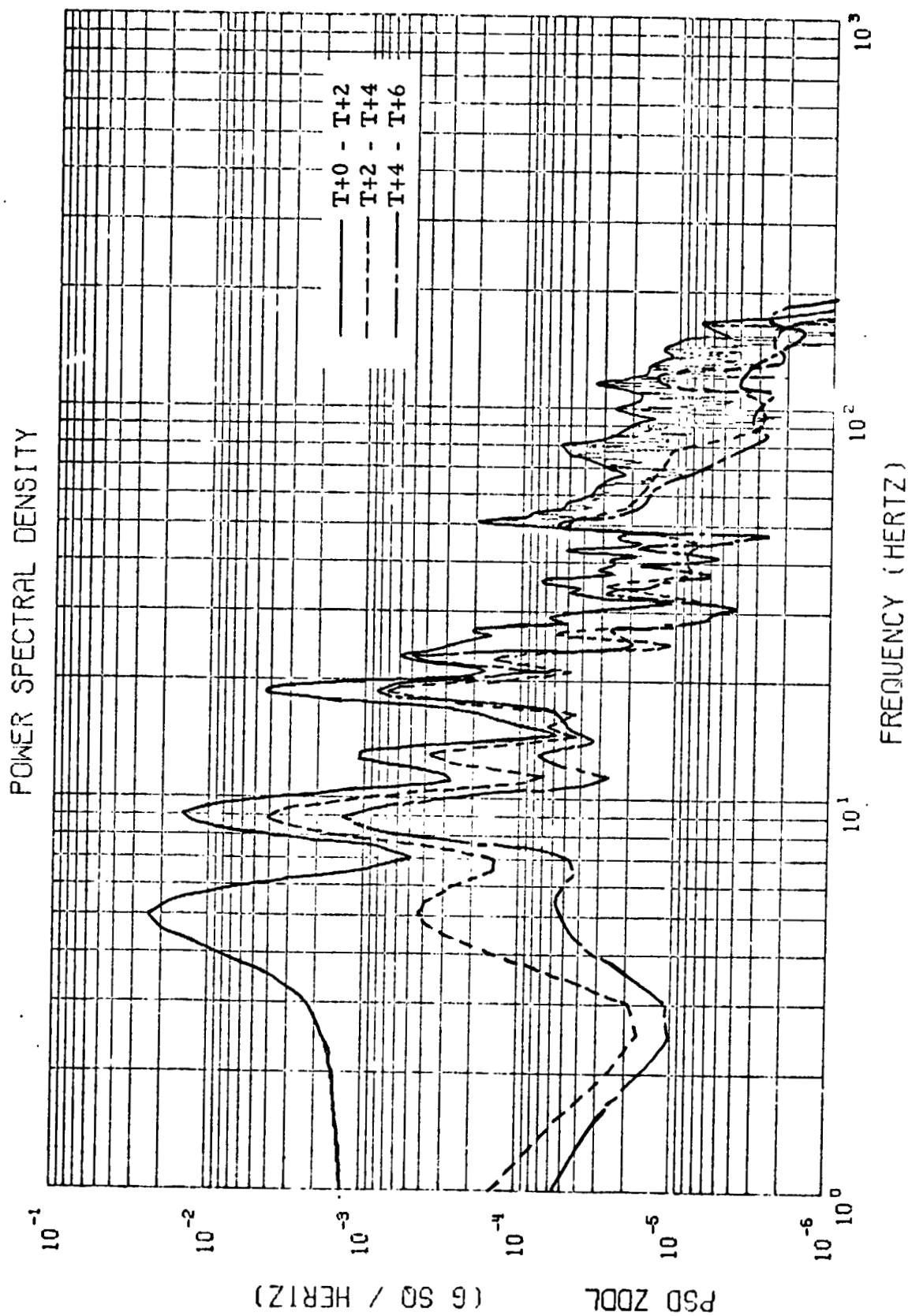
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YDOL

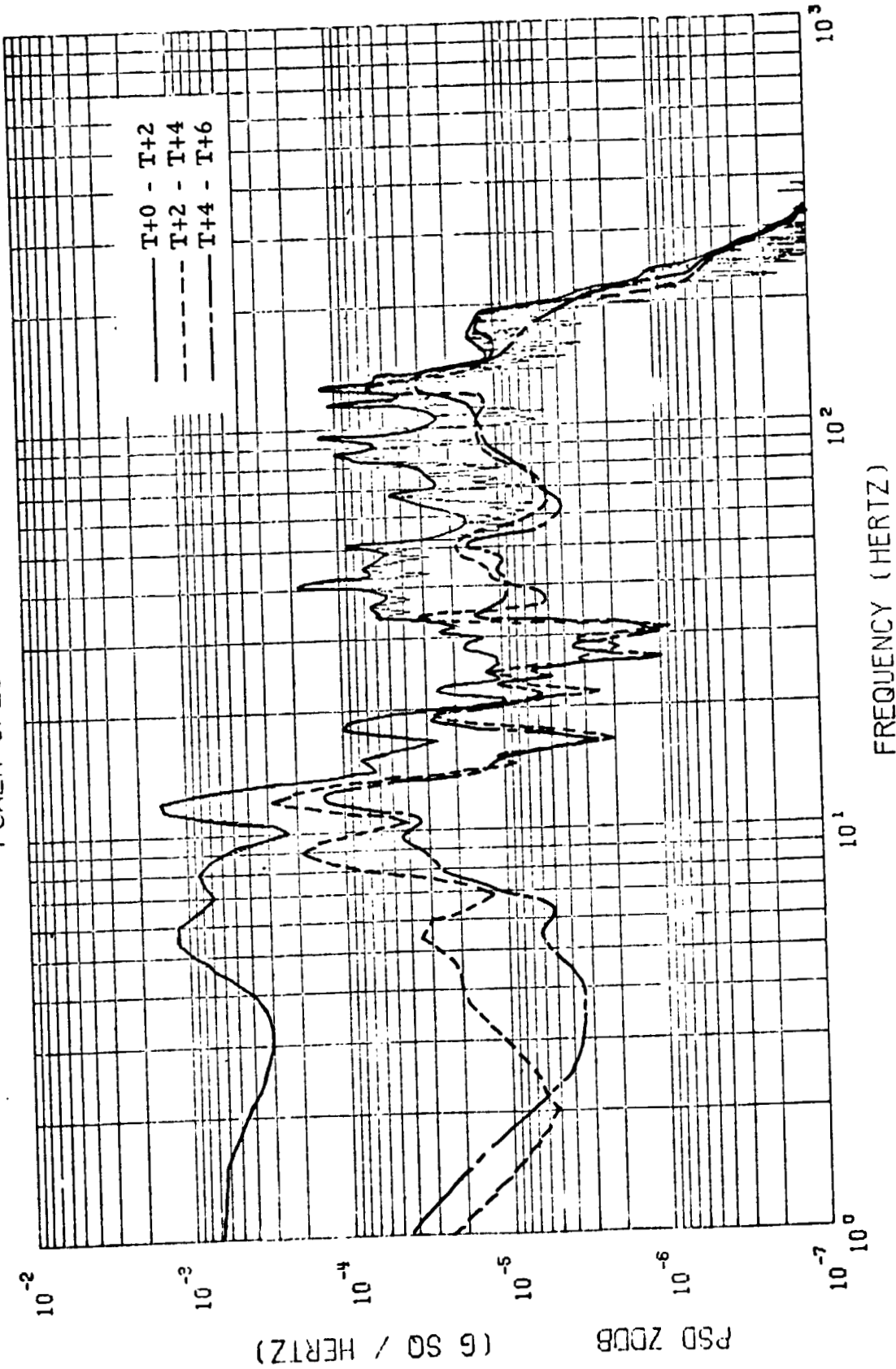
TC-1 / VDS DATA (LEG-29)

Figure 1.15

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POWER SPECTRAL DENSITY



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TC-1 / VDS DATA (LRC-3A)

STAGE 0 IGN

Z00B

Figure 1.17

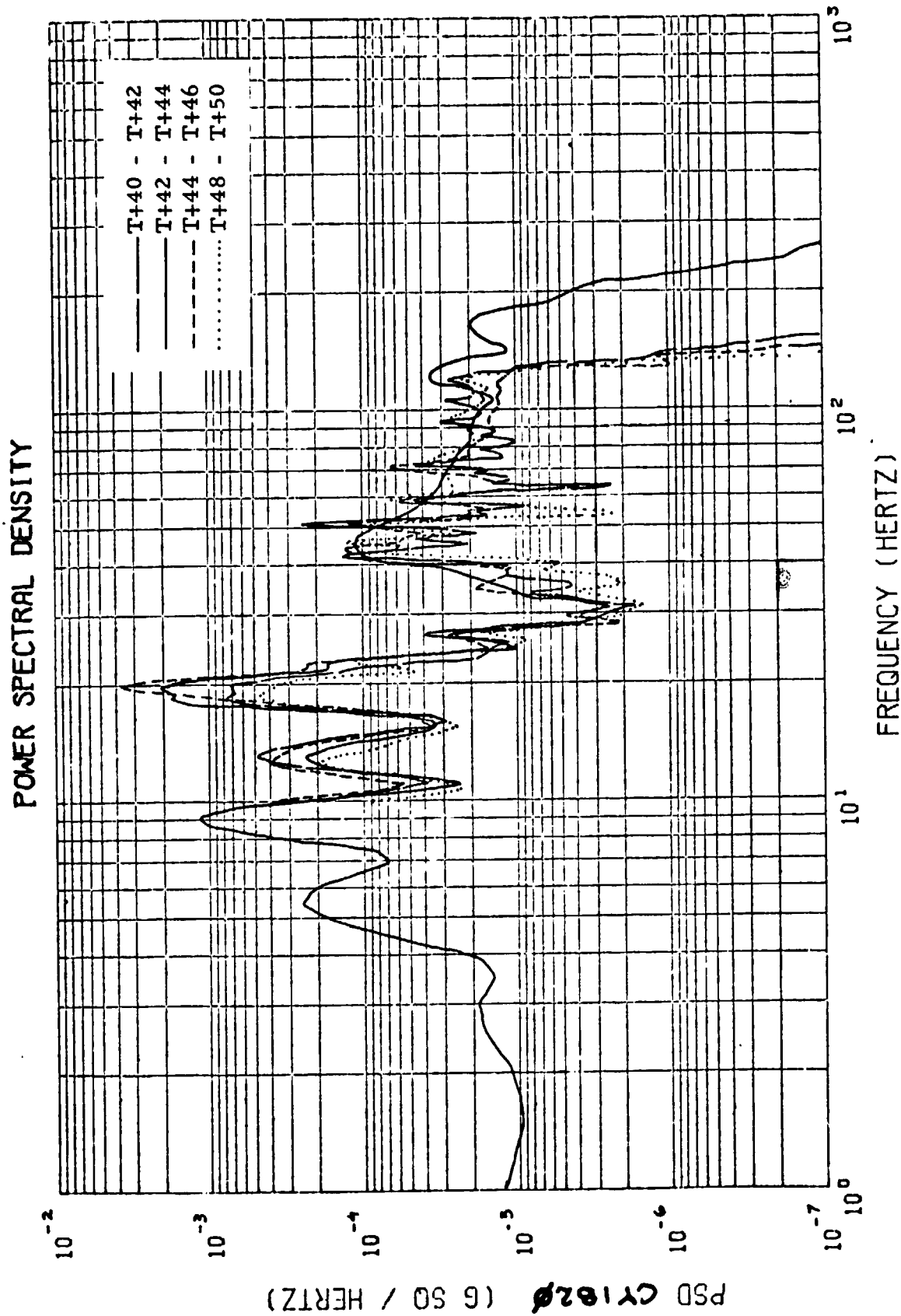


Figure 1.18 TC-1 VDS Summary Data - Max Q - CY1820

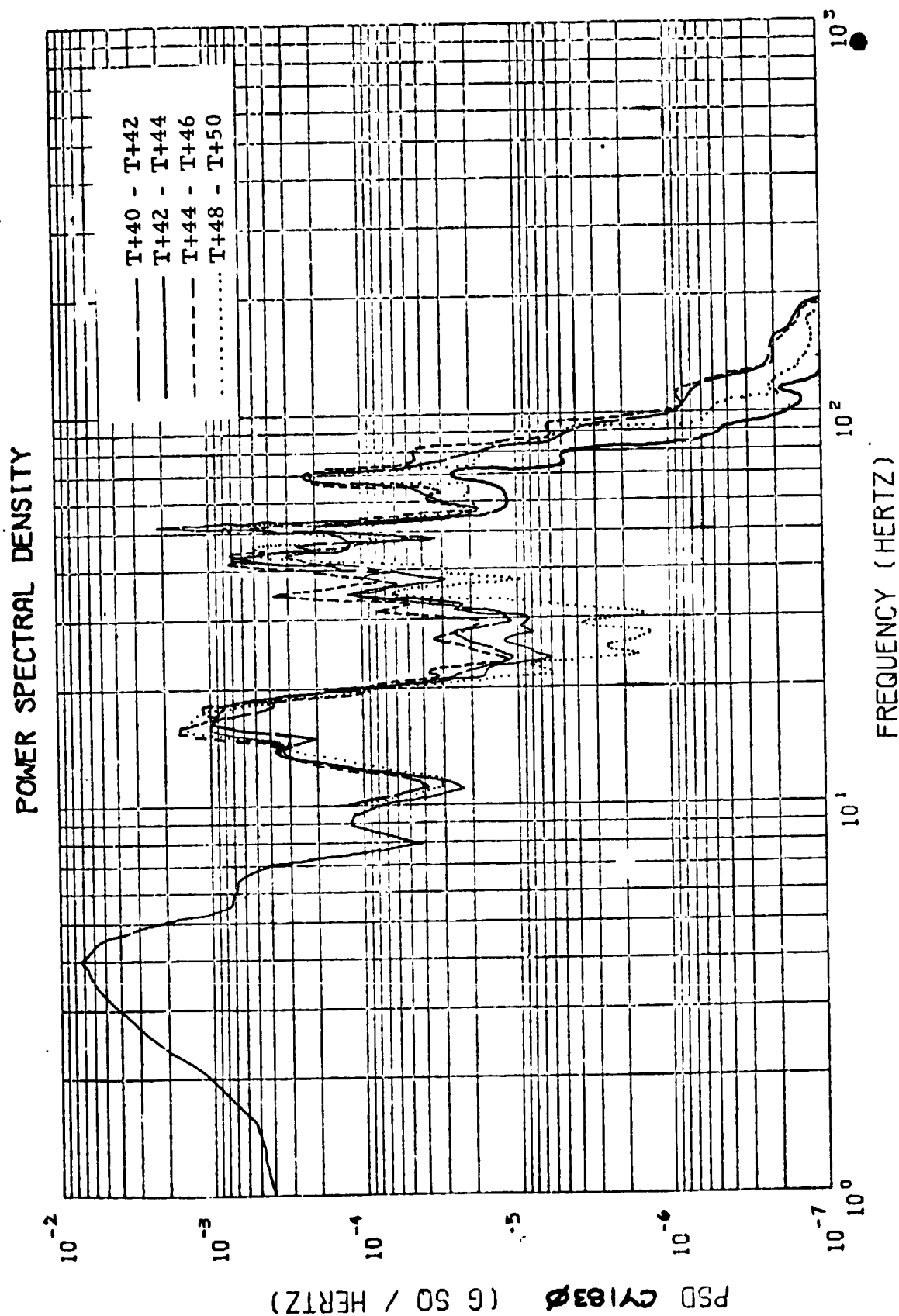


Figure 1.19 TC-1 VDS Summary Data -- Max Q -- CY1830

POWER SPECTRAL DENSITY

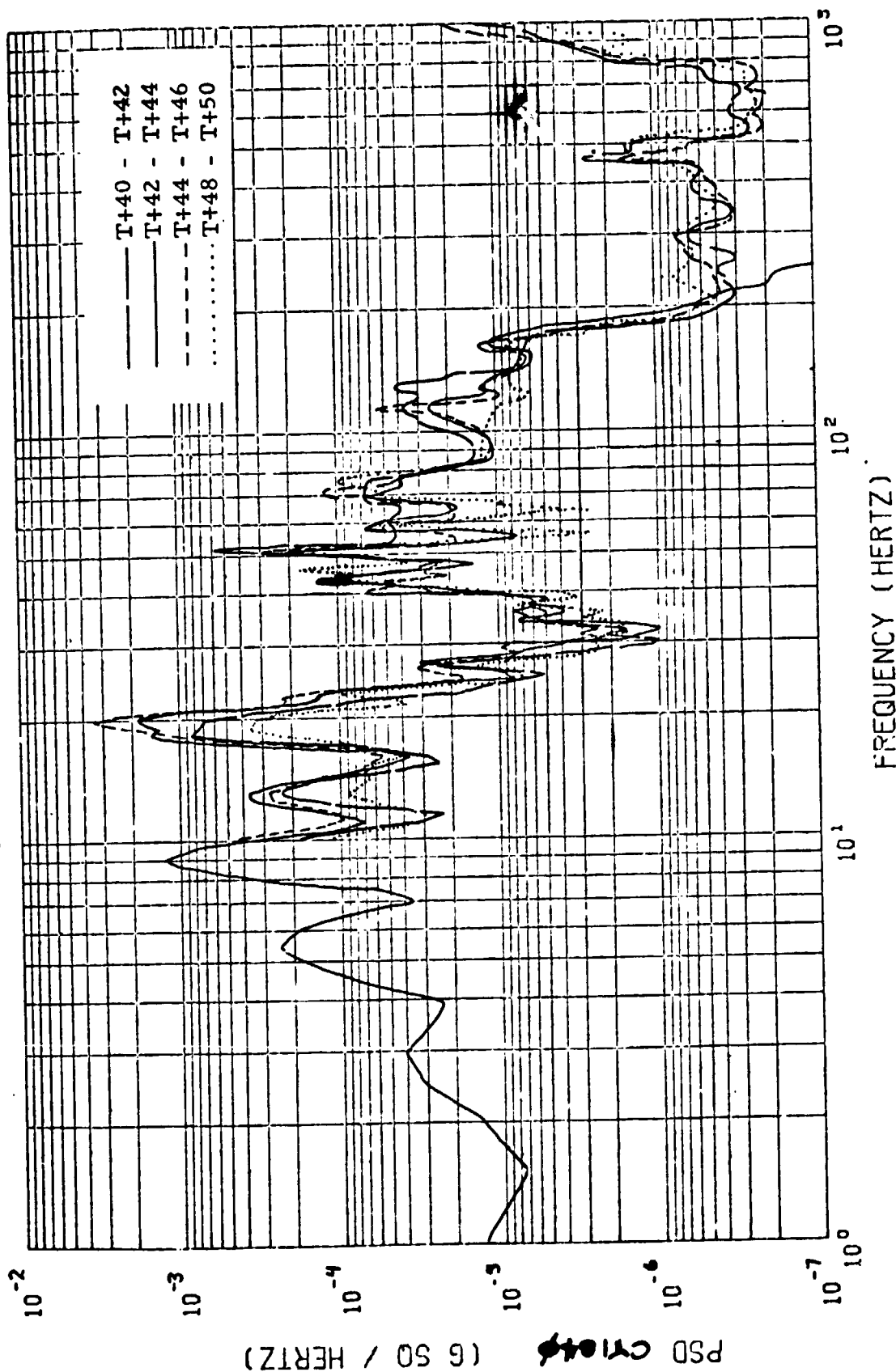


Figure 1.20 TC-1 VDS Summary Data -- Max Q -- CY1840

POWER SPECTRAL DENSITY

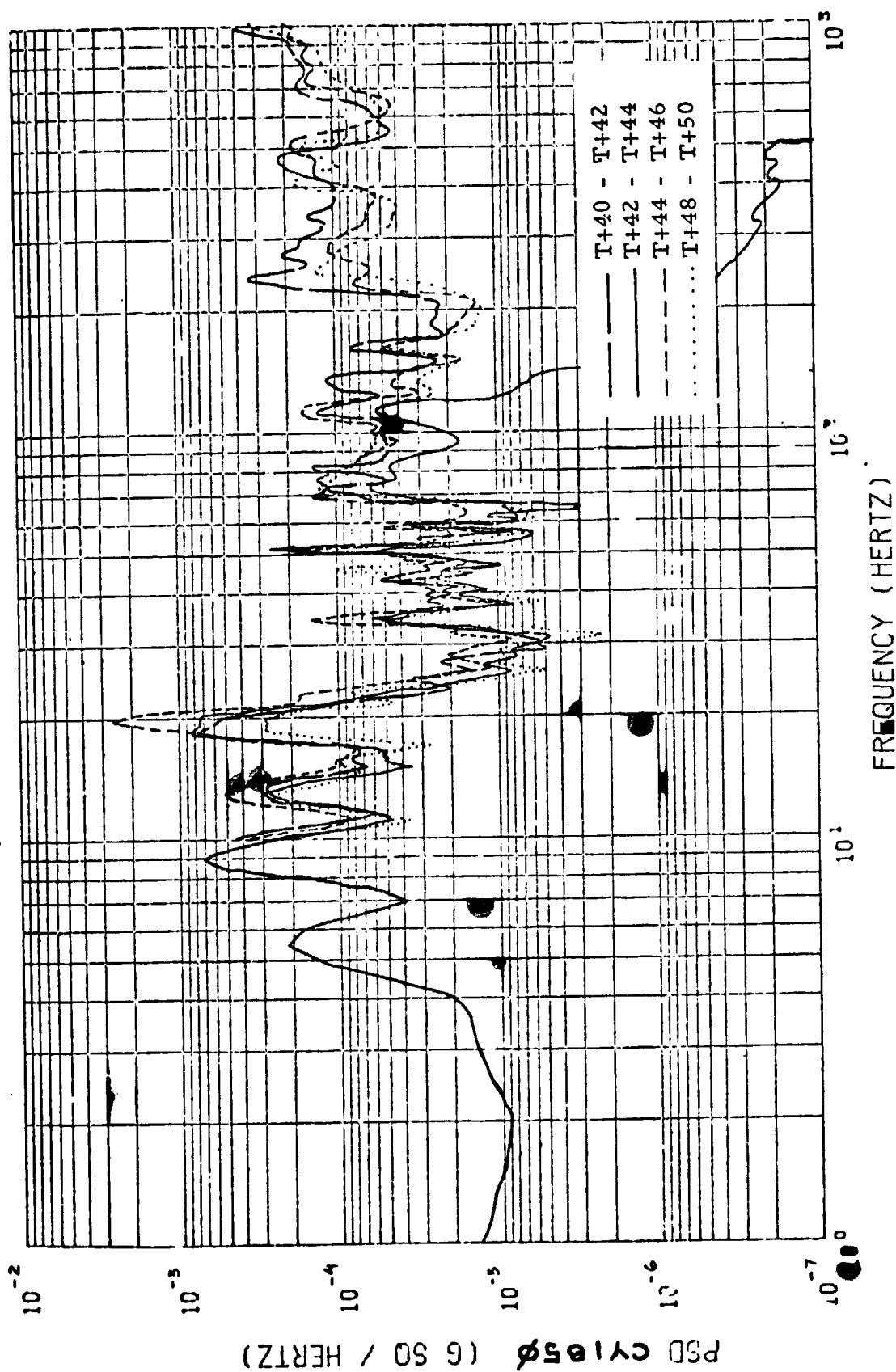


Figure 1.21 AC-1 VDS Summary Data --- Mes 0 --- CY1050

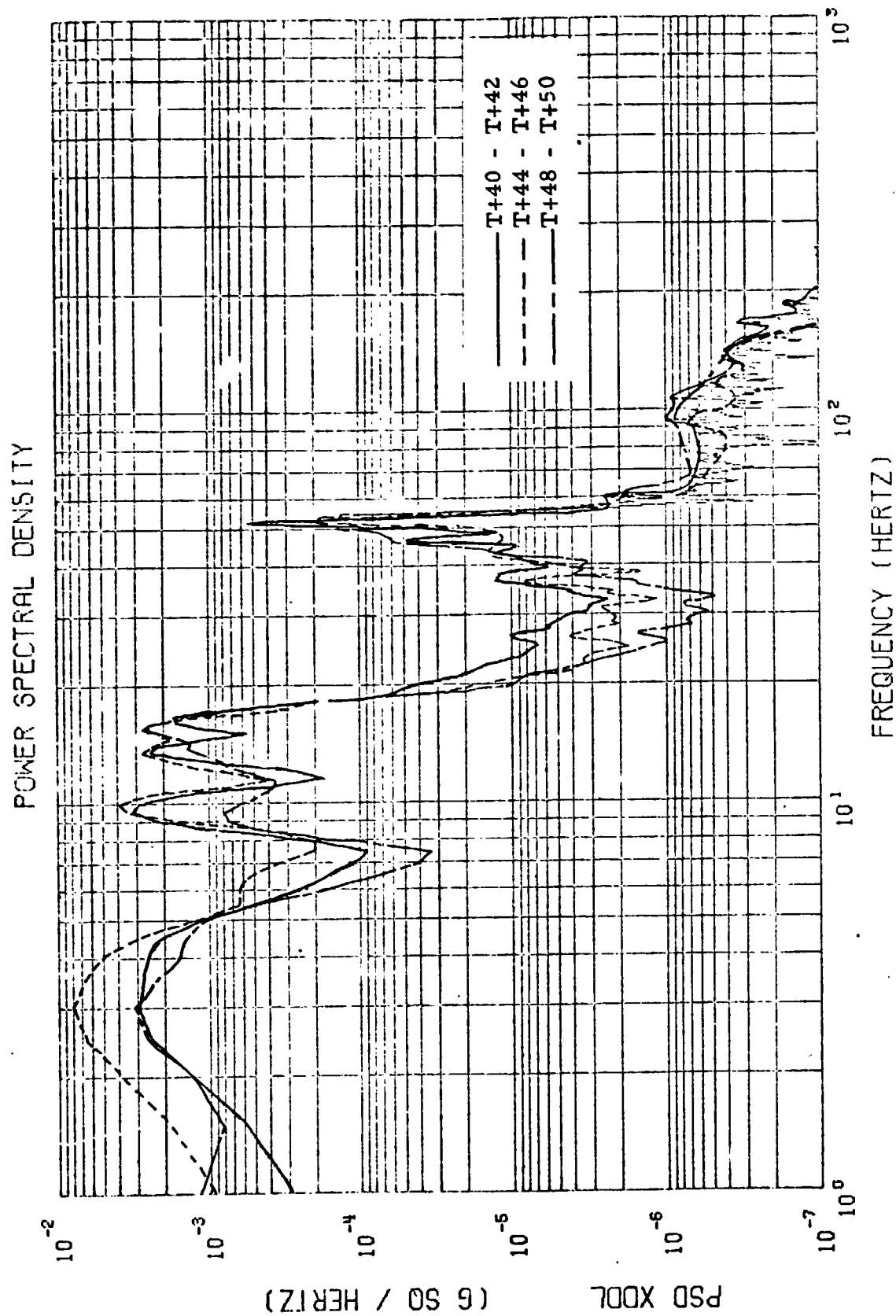


Figure 1.22 TC-1 VDS Summary Data --- Max Q --- XDDL

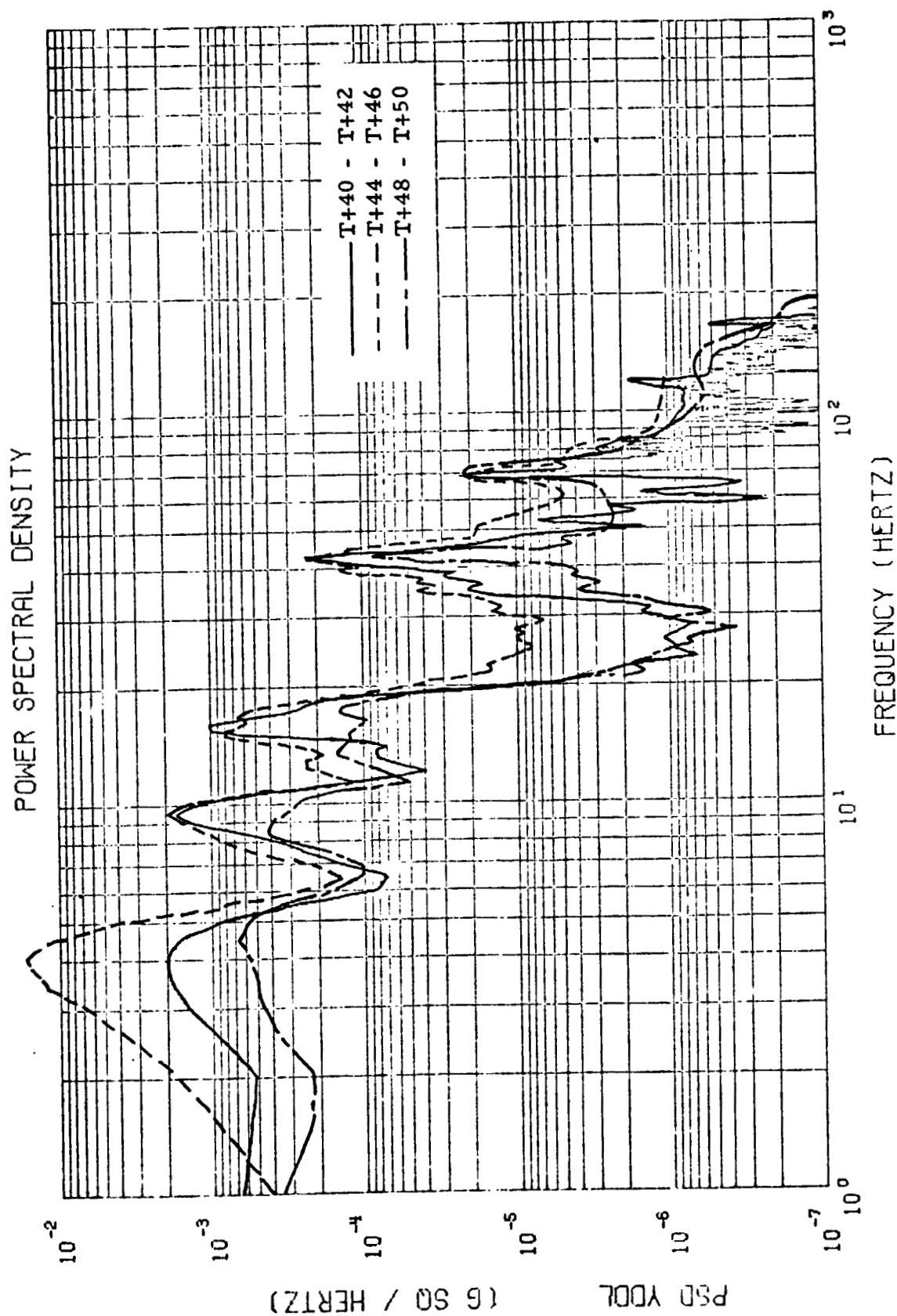


Figure 1.23 TC-1 VDS Summary Data --- Max Q --- YDDL

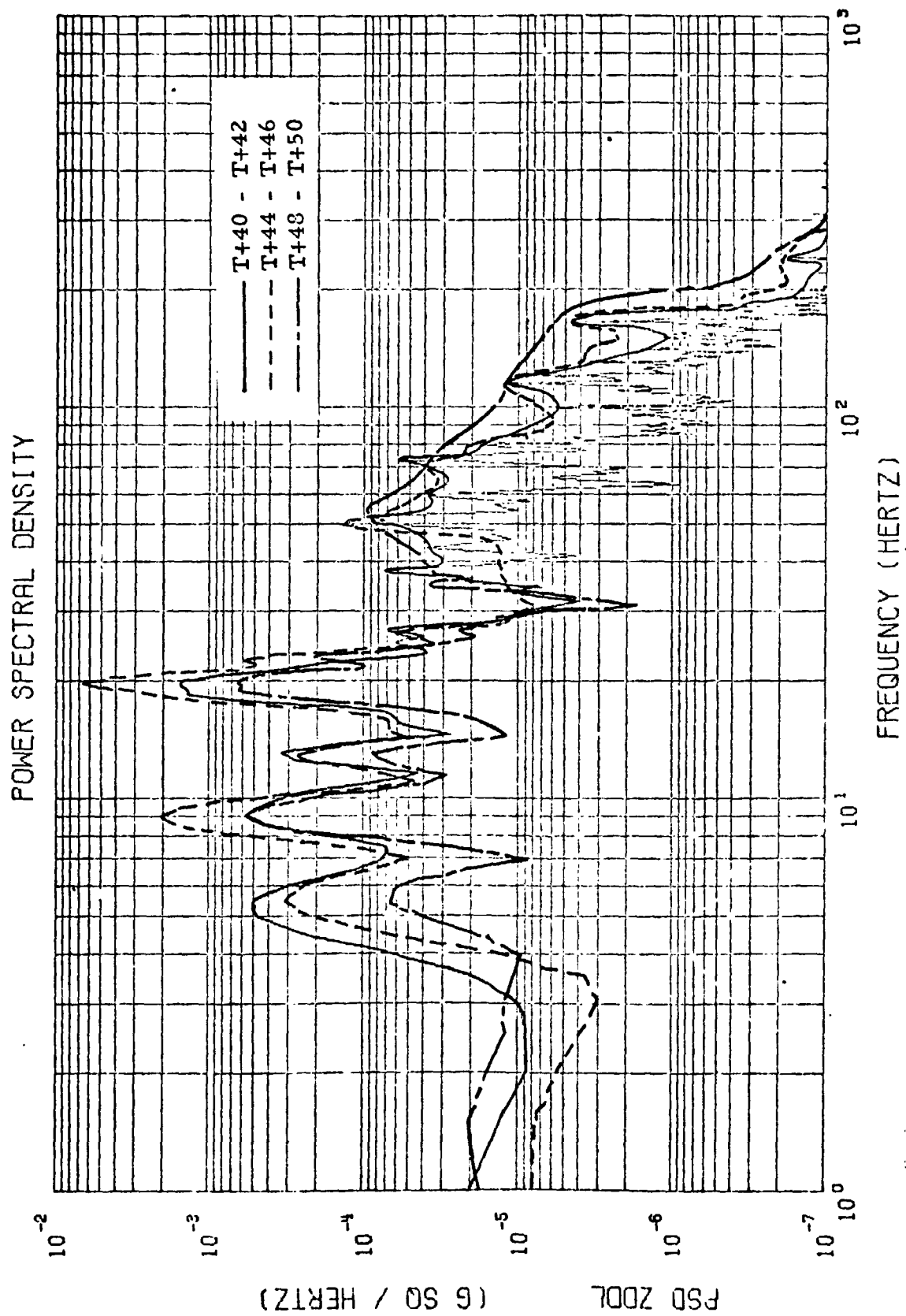


Figure 1.24 TC-1 VDS Summary Data --- Max Q --- ZDDL

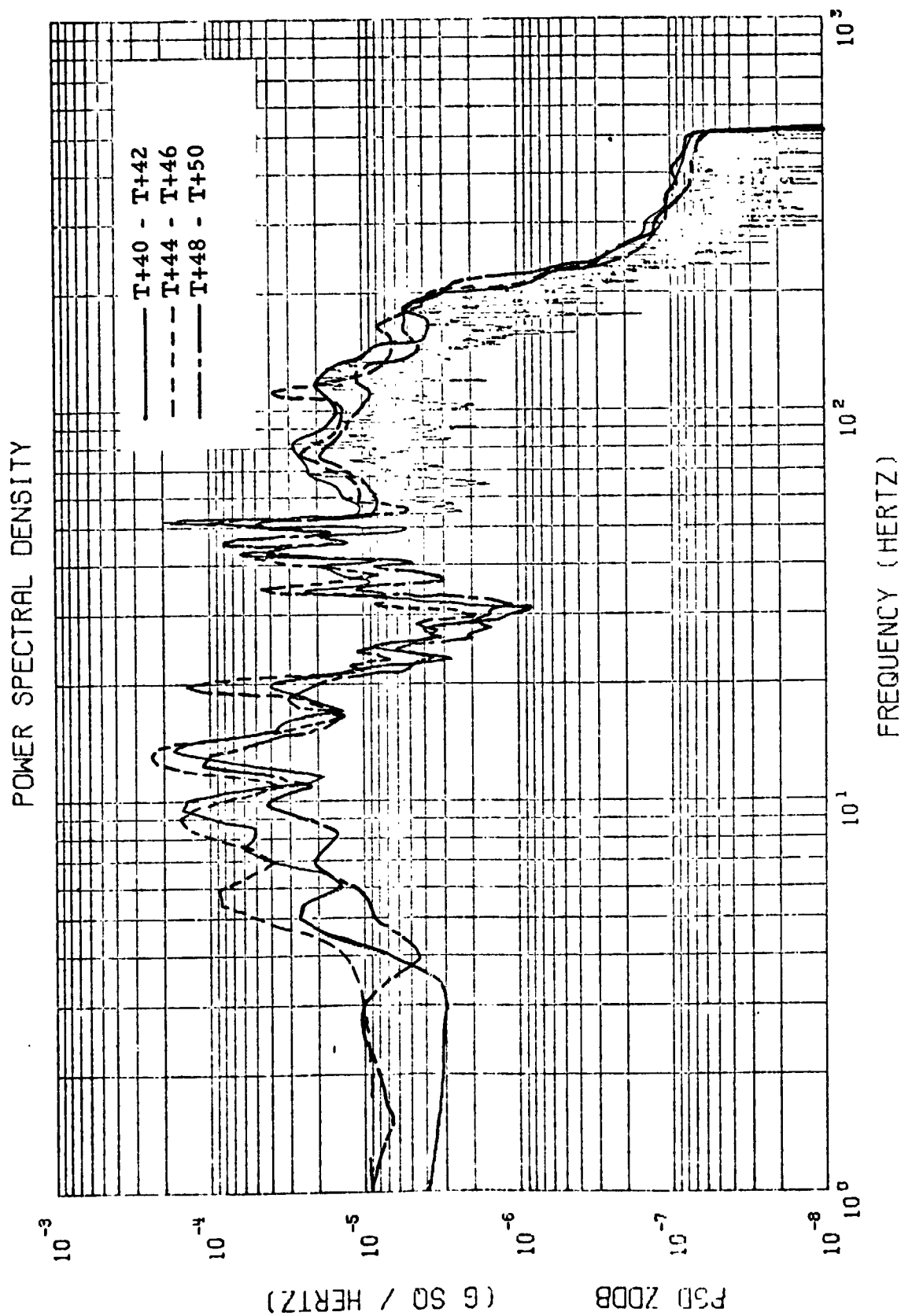


Figure 1.25 TC-1 VDS Summary Data --- Max Q --- ZDDB

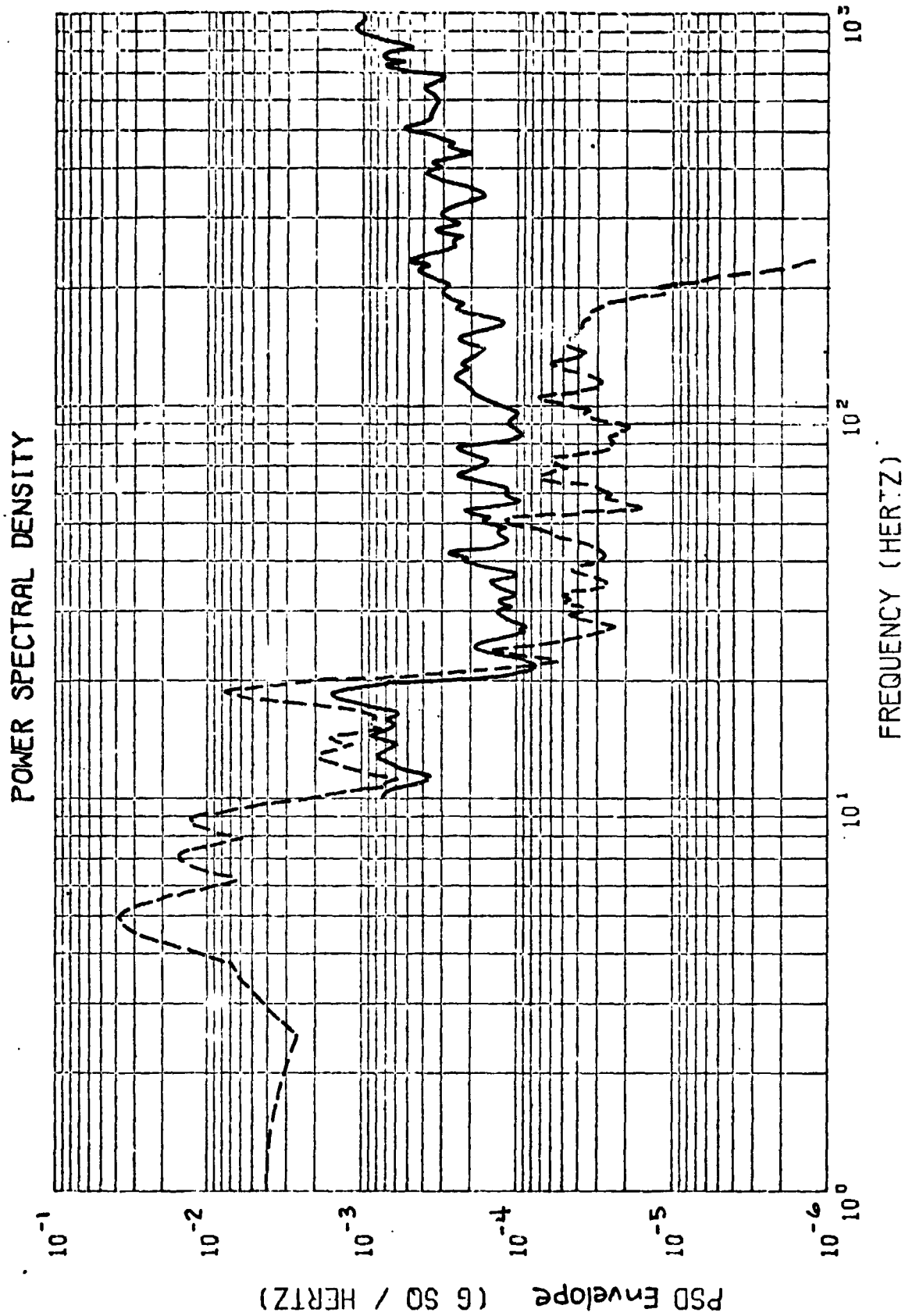
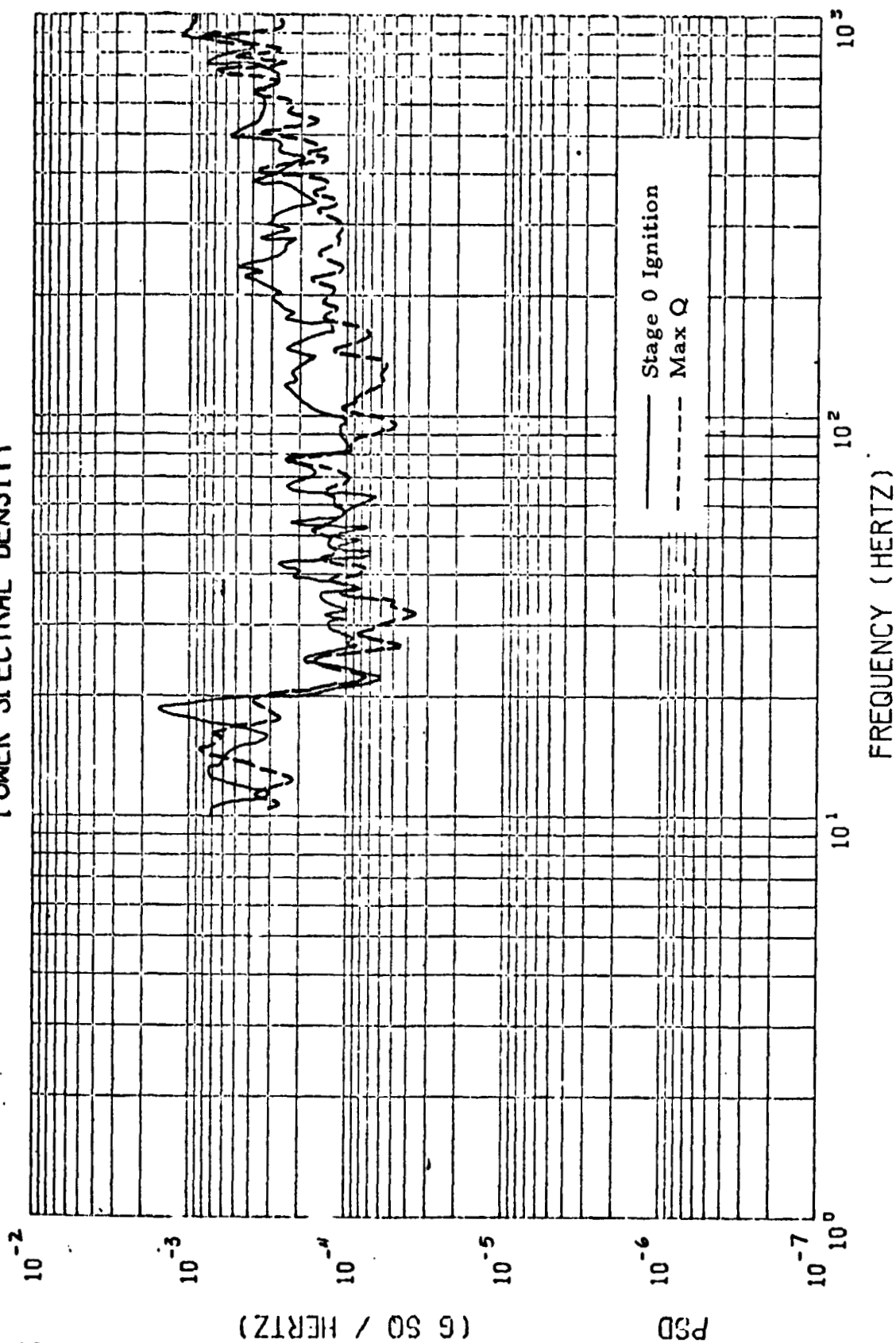


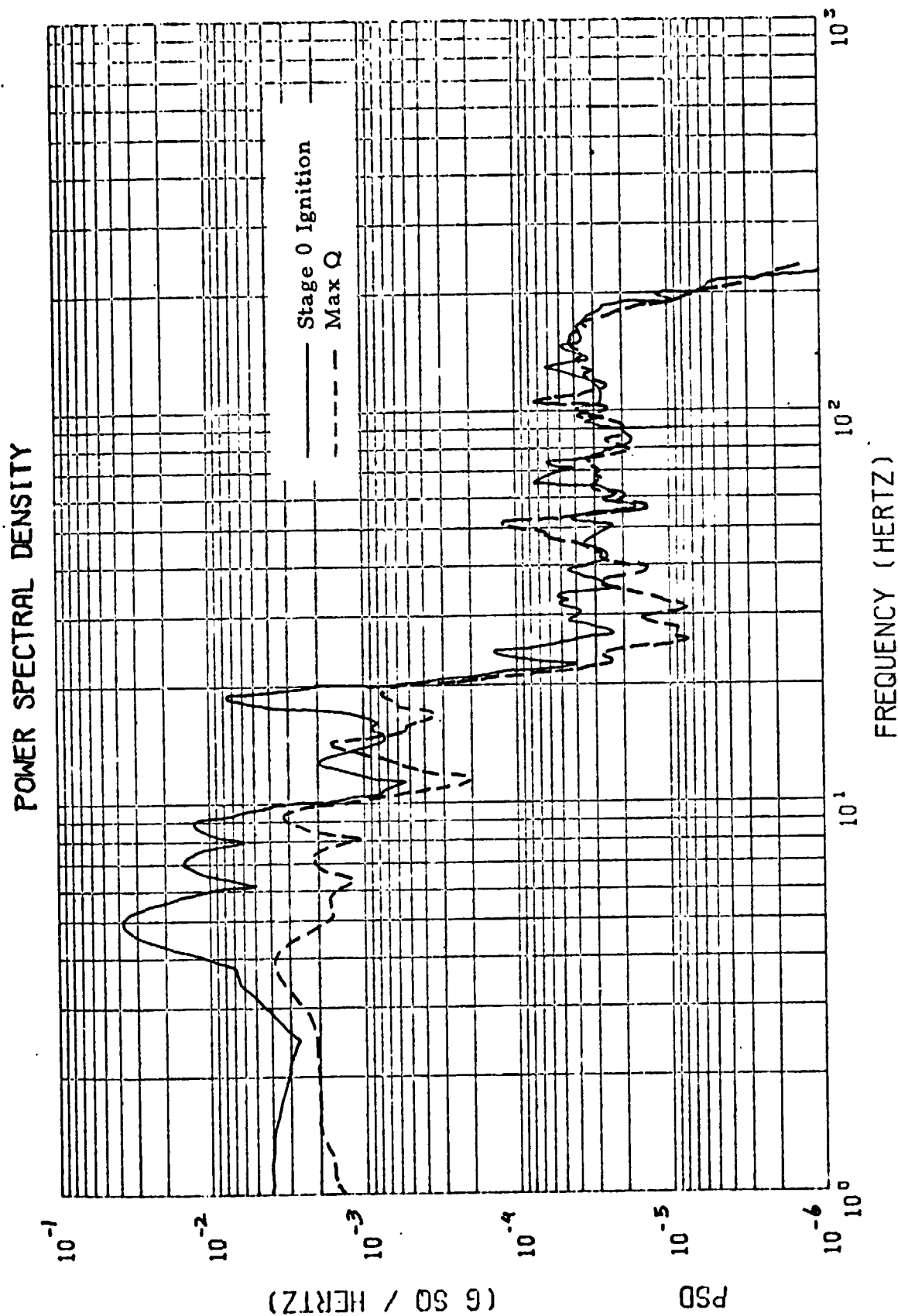
Figure 1.26 TC-4 Viking A Summary PSD Data

POWER SPECTRAL DENSITY



Envelopes of Composite Stage 0 Ignition & Composite Max Q PSD

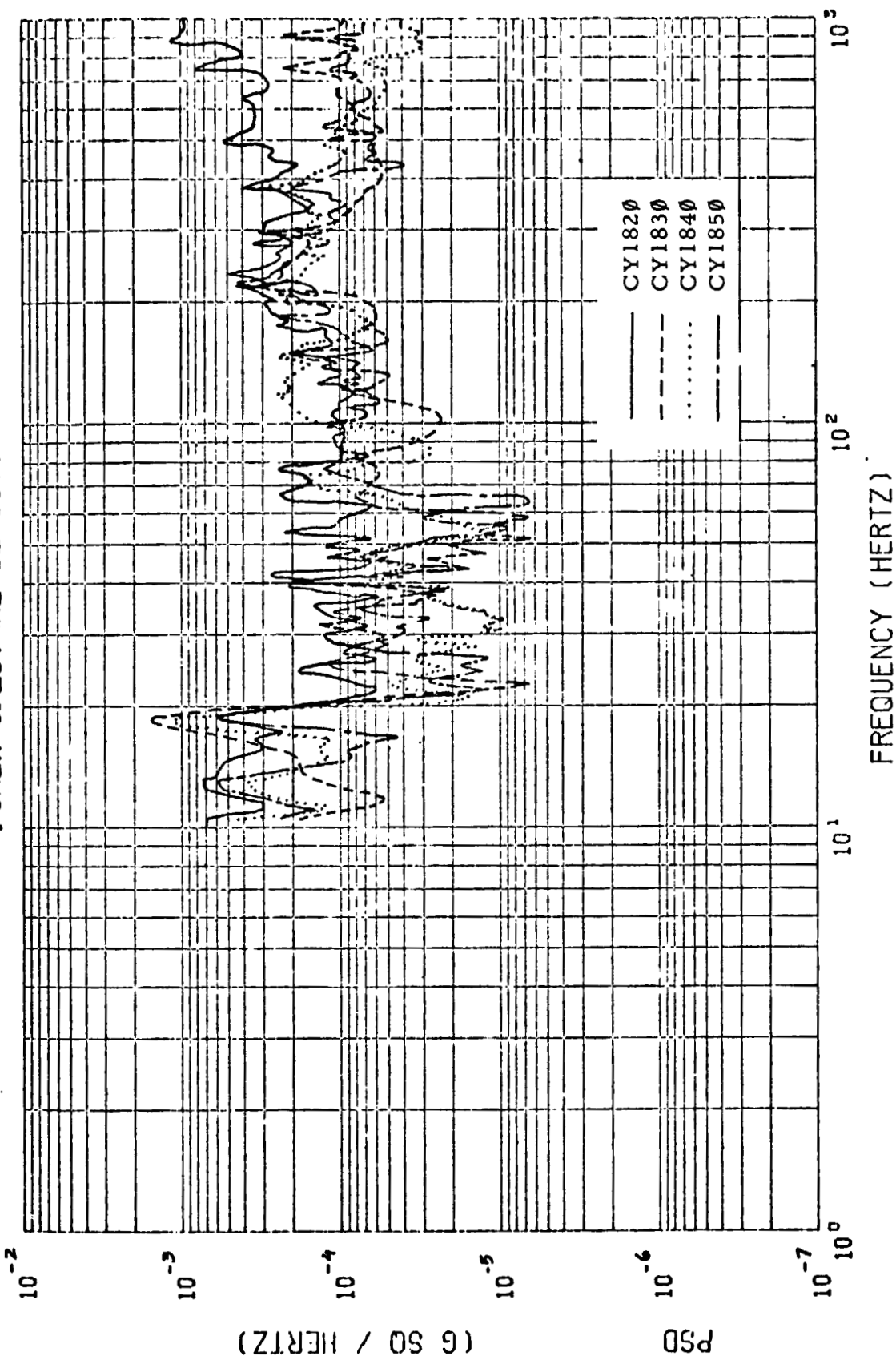
Figure 1.27 TC-4 Viking A Summary Data - Bus Accelerometers



Envelopes of Composite Stage 0 Ignition & Composite Max Q PSD

Figure 1.29 TC-4 Viking A Summary Data - VLC cg Accelerations

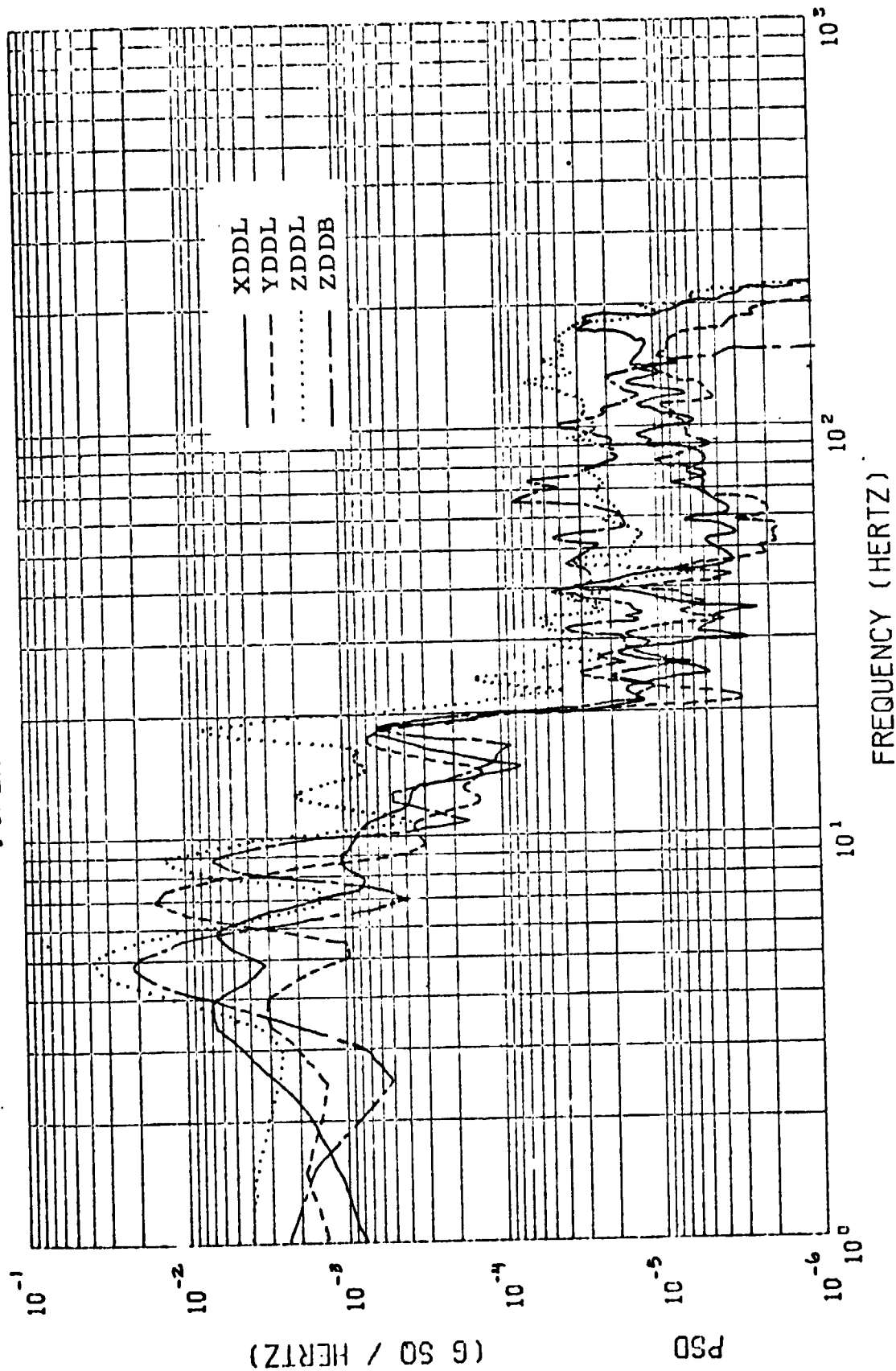
POWER SPECTRAL DENSITY



Envelopes of Stage 0 Ignition Composites

Figure 1.29 TC-4 Viking A Summary Data Bus Accelerometers

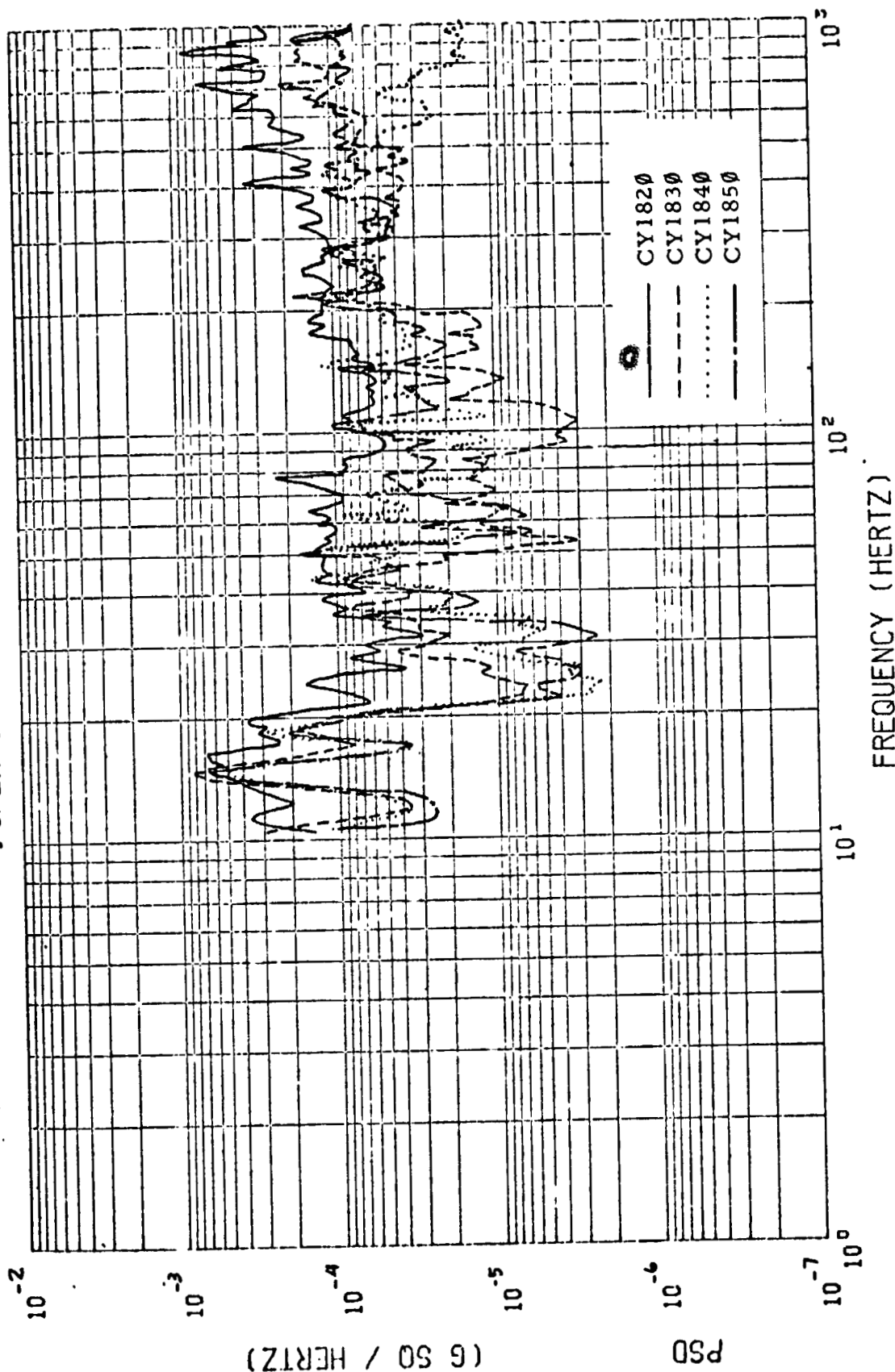
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Envelopes of Stage 0 Ignition Composites

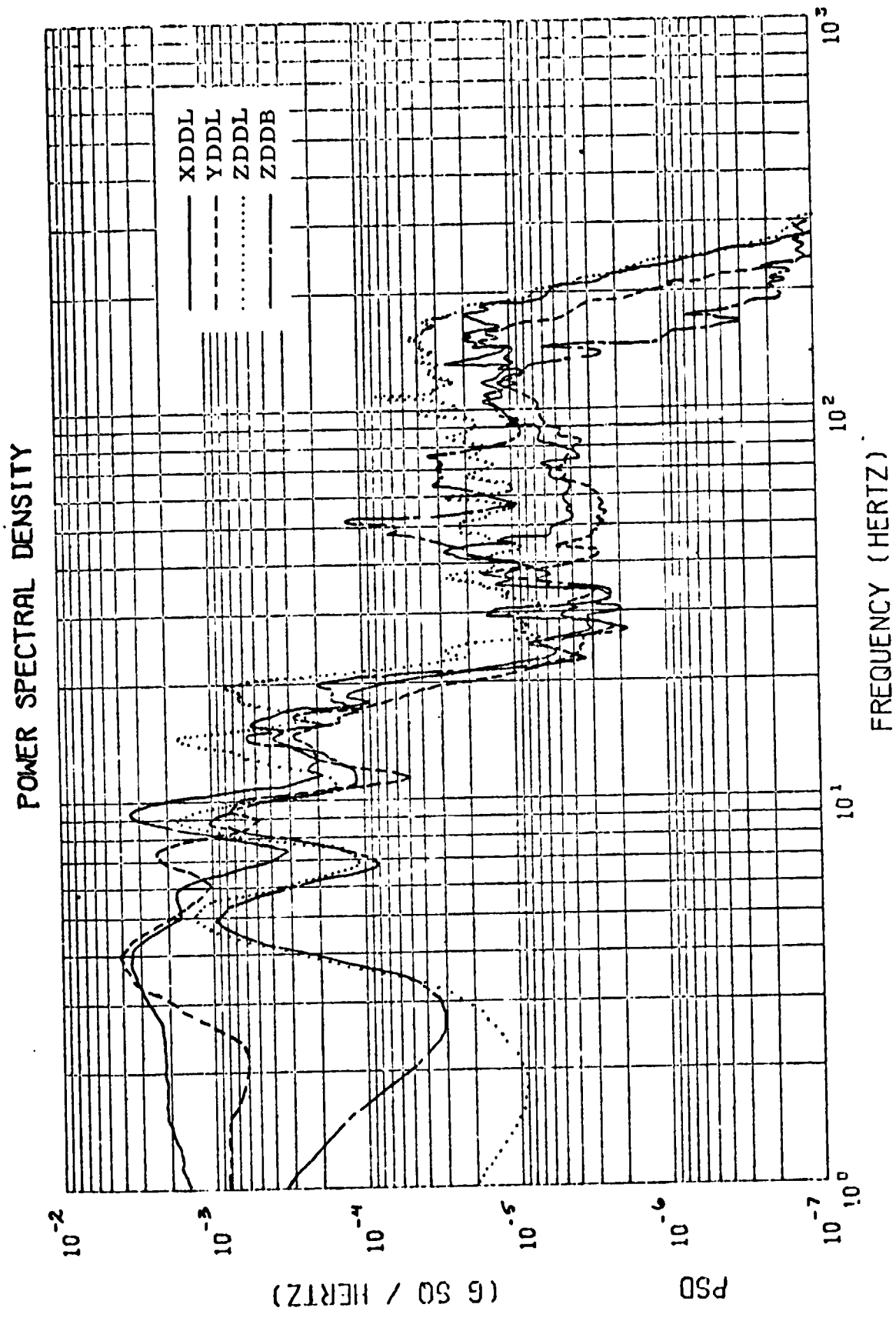
Figure 1.30 TC-4 Viking A Summary Data, VLC cg Accelerations

POWER SPECTRAL DENSITY



Envelopes of Max Q Composite Plots

Figure 1.31 TC-4 Viking A Summary Data - Bus Accelerometers



Envelopes of Max Q Composite Plots

Figure 1.32 TC-4 Viking A Summary Data - VLC cg Accelerations

POWER SPECTRAL DENSITY

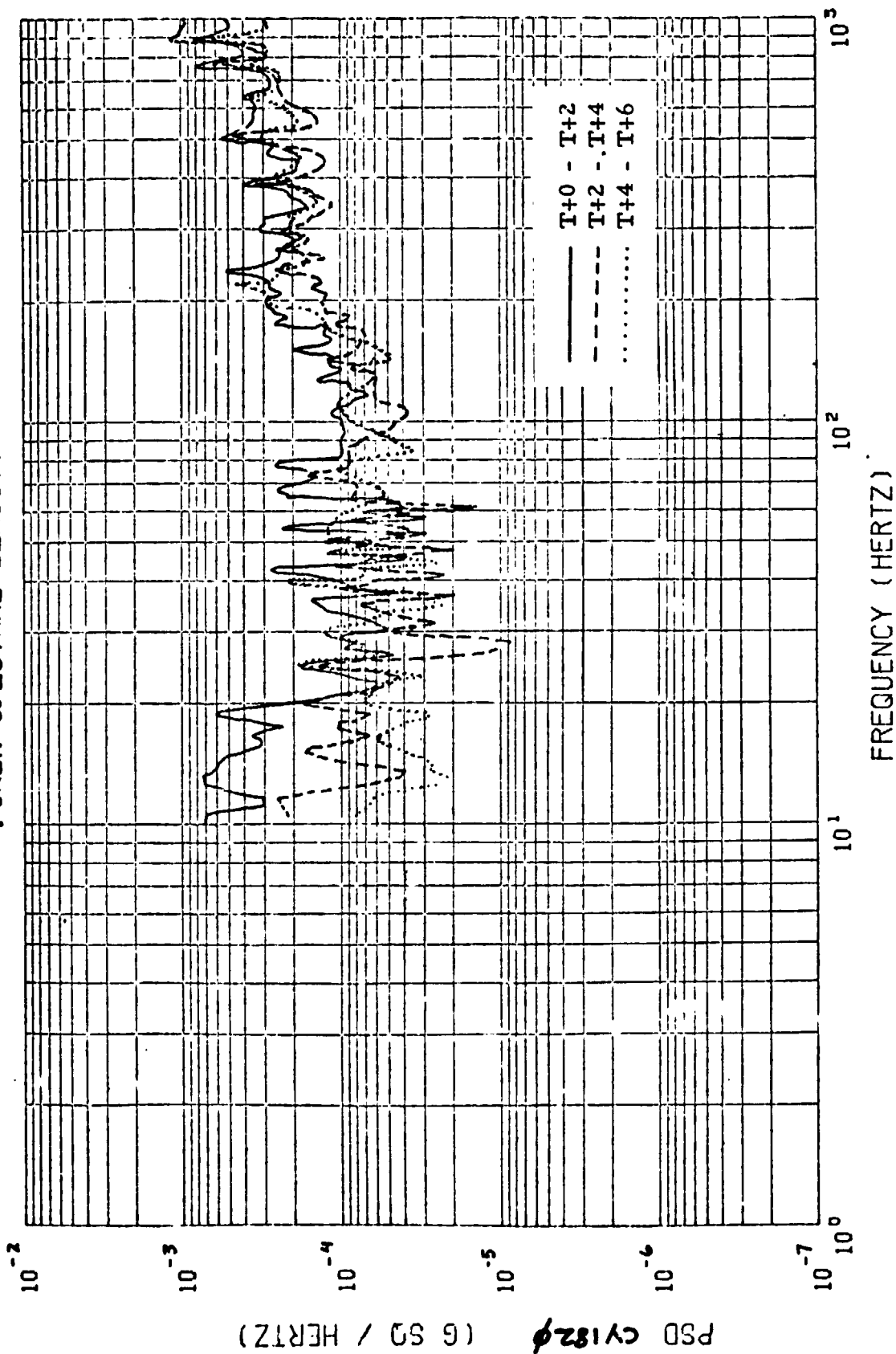


Figure 1.33 TC-4 Viking A Stage 0 Ignition Summary CY 1820

POWER SPECTRAL DENSITY

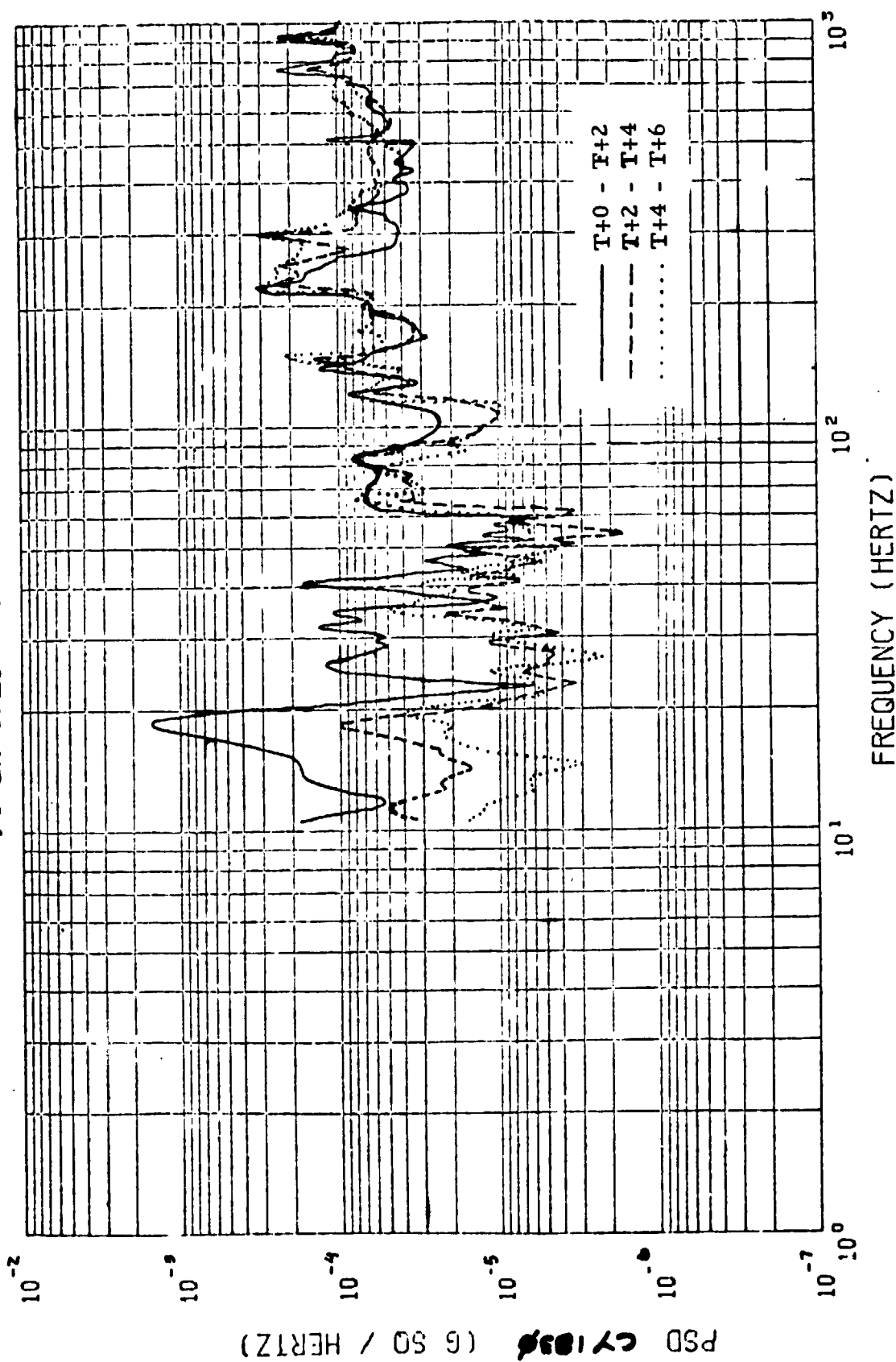


Figure 1.34 TC-4 Viking A Stage 0 Ignition Summary - CY1830

POWER SPECTRAL DENSITY

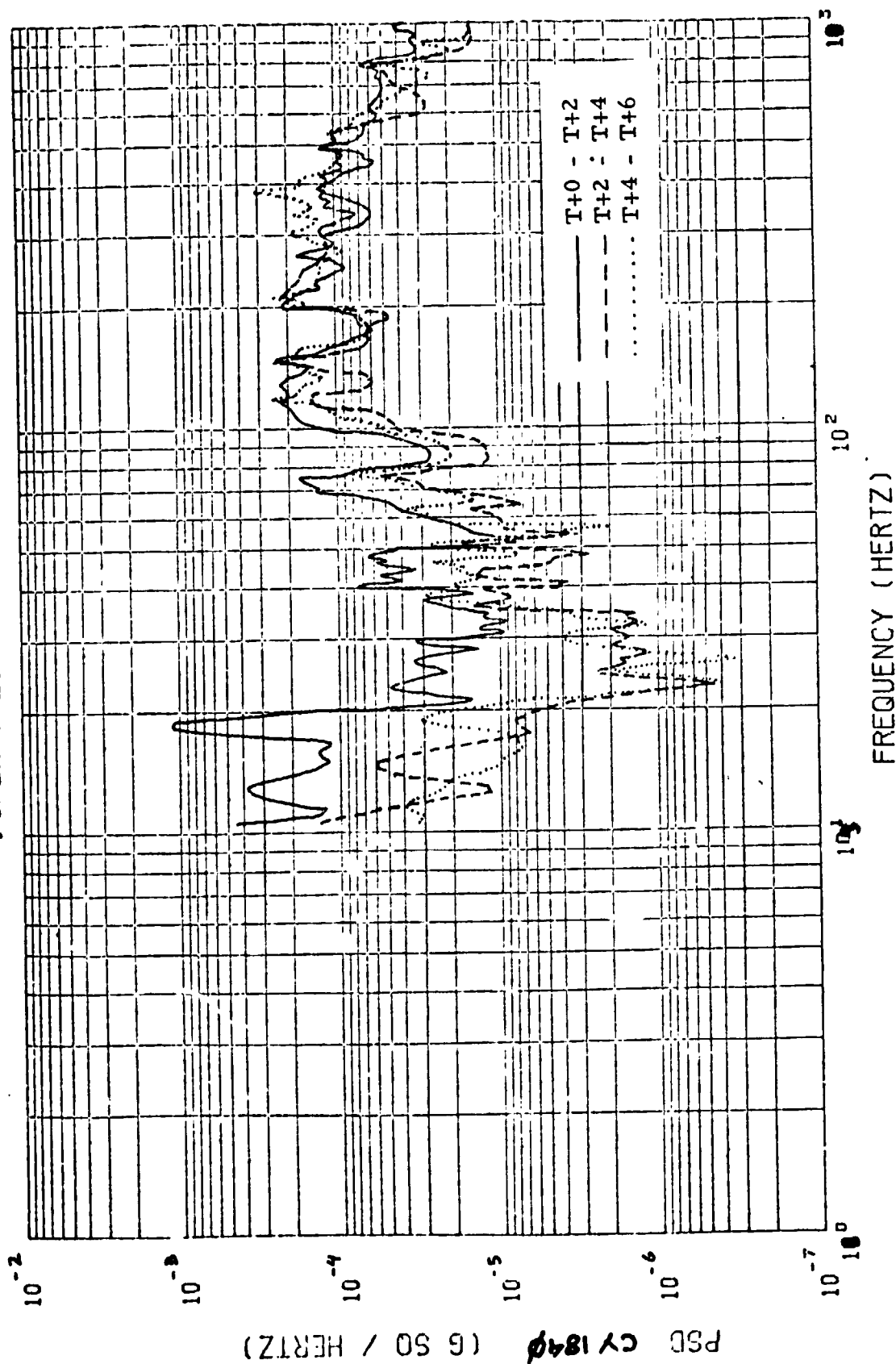


Figure 1.35 ZC-B Viking A Stage 0 Ignition Summary - CY1840

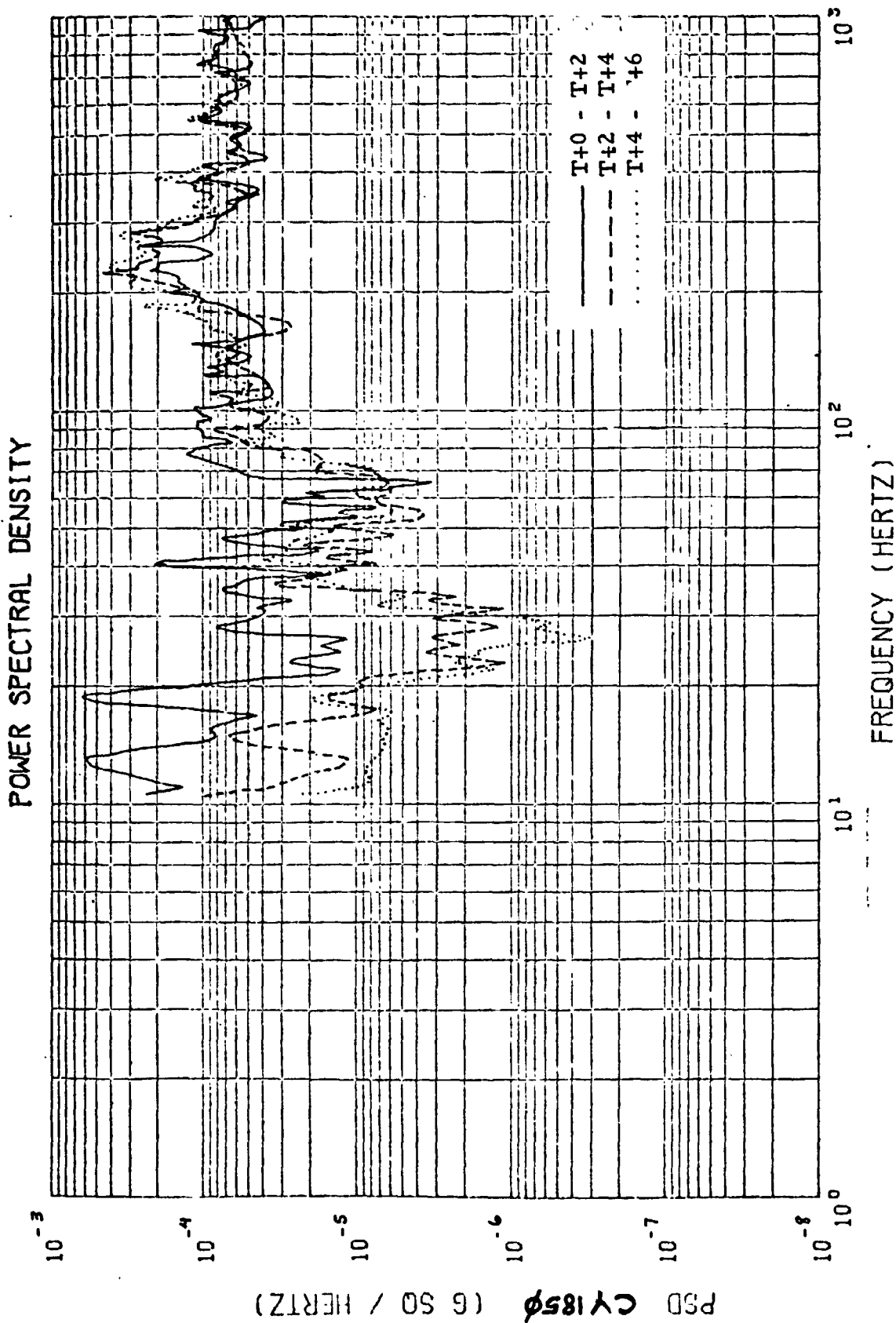


Figure I.36 TC-4 Viking A Stage 0 Ignition Summary - CY1850

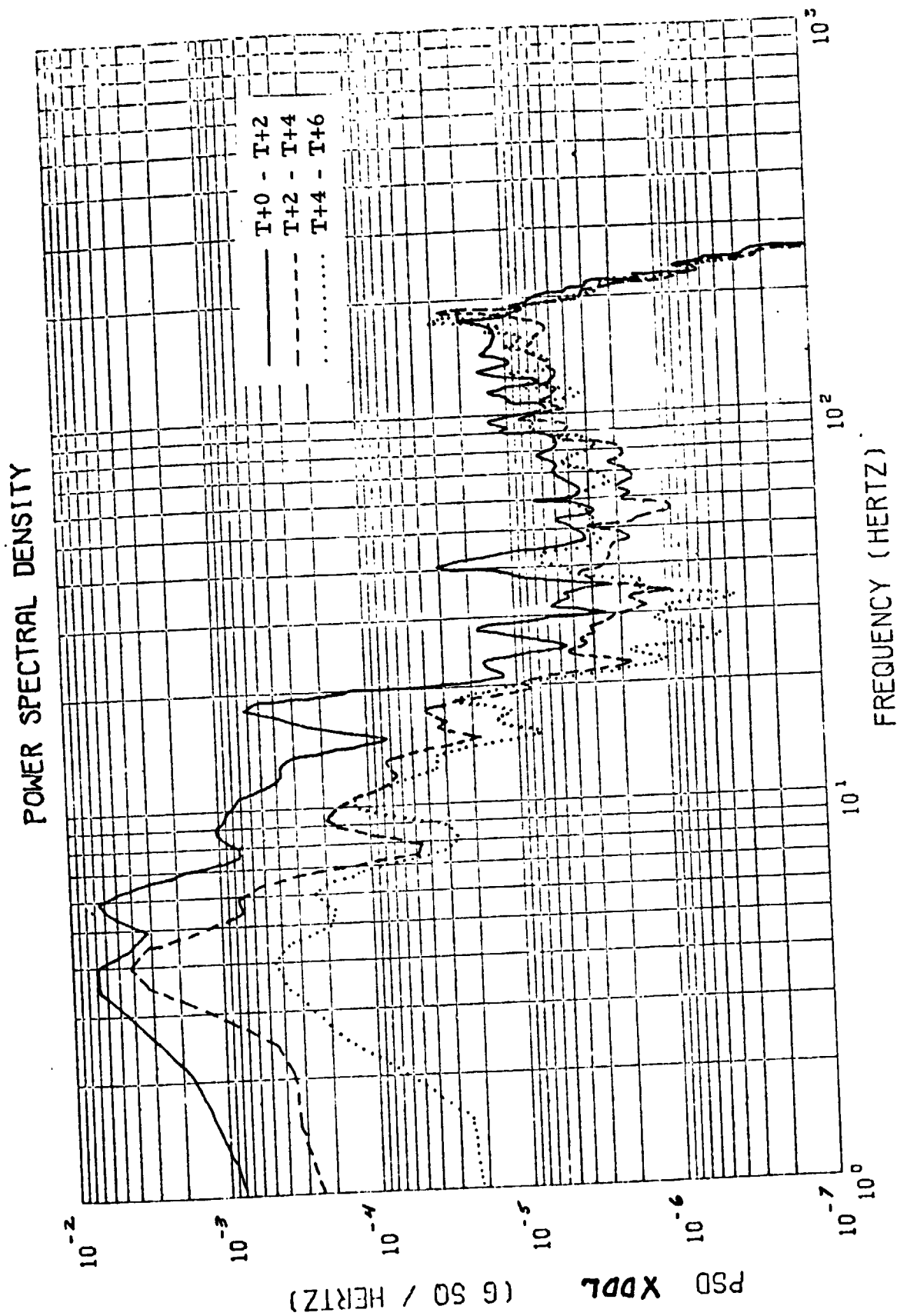


Figure 1.37 TC-4 Viking A - Stage 0 Ignition Summary XDDL

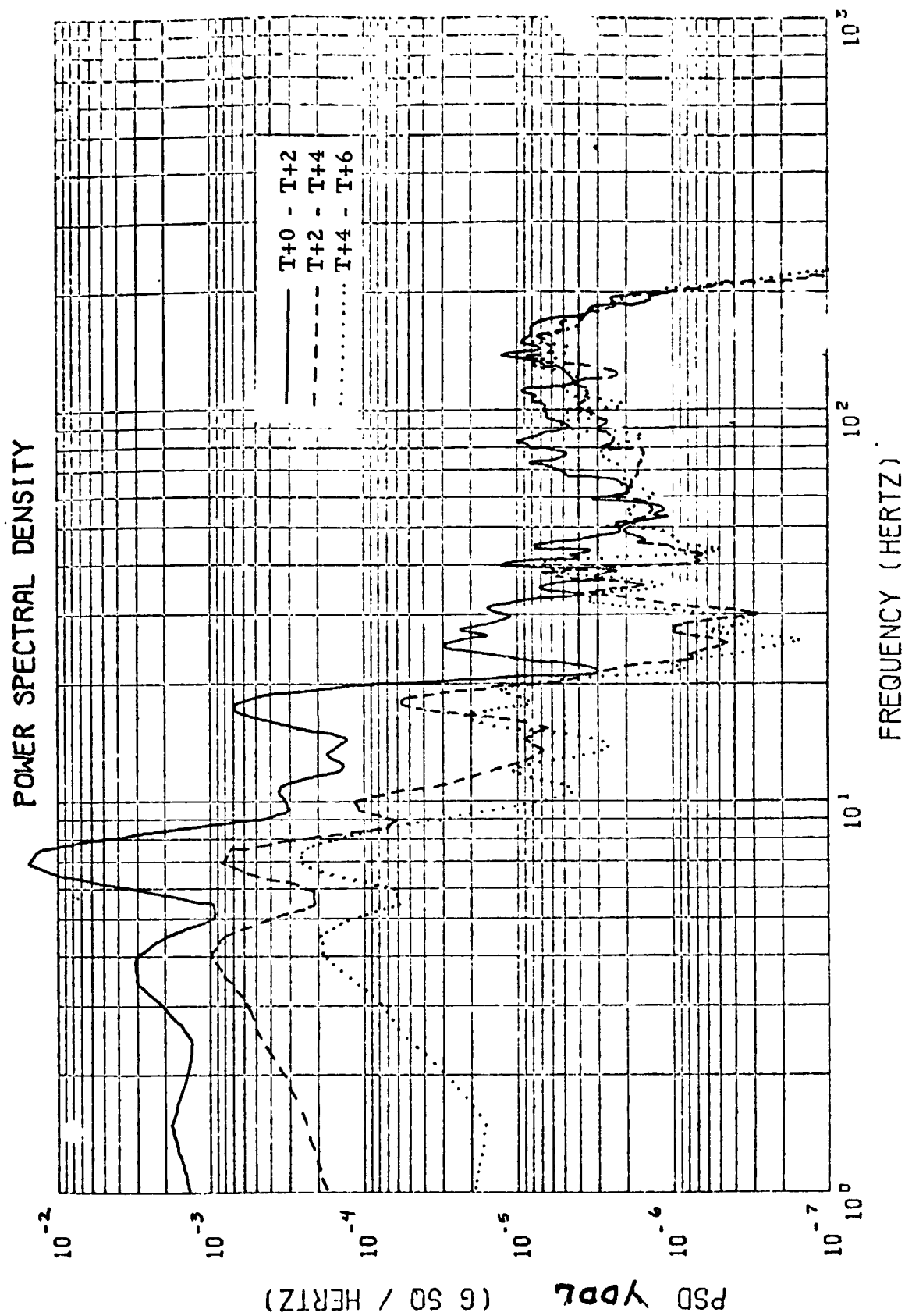


Figure 1.38 TC-4 Viking A - Stage 0 Ignition Summary YDDL

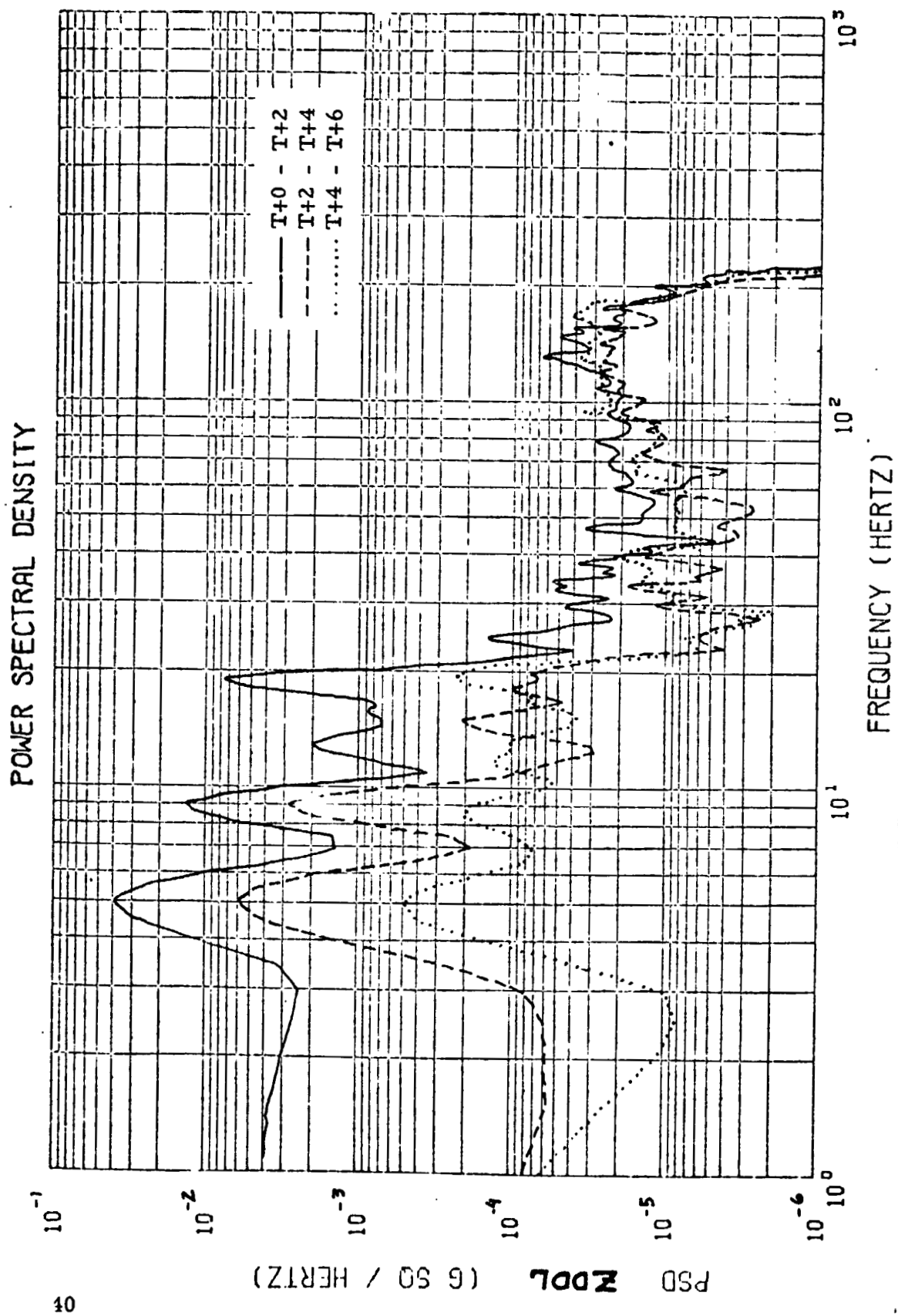


Figure 1.39 TC-4 Viking A - Stage 0 Ignition Summary ZDDL

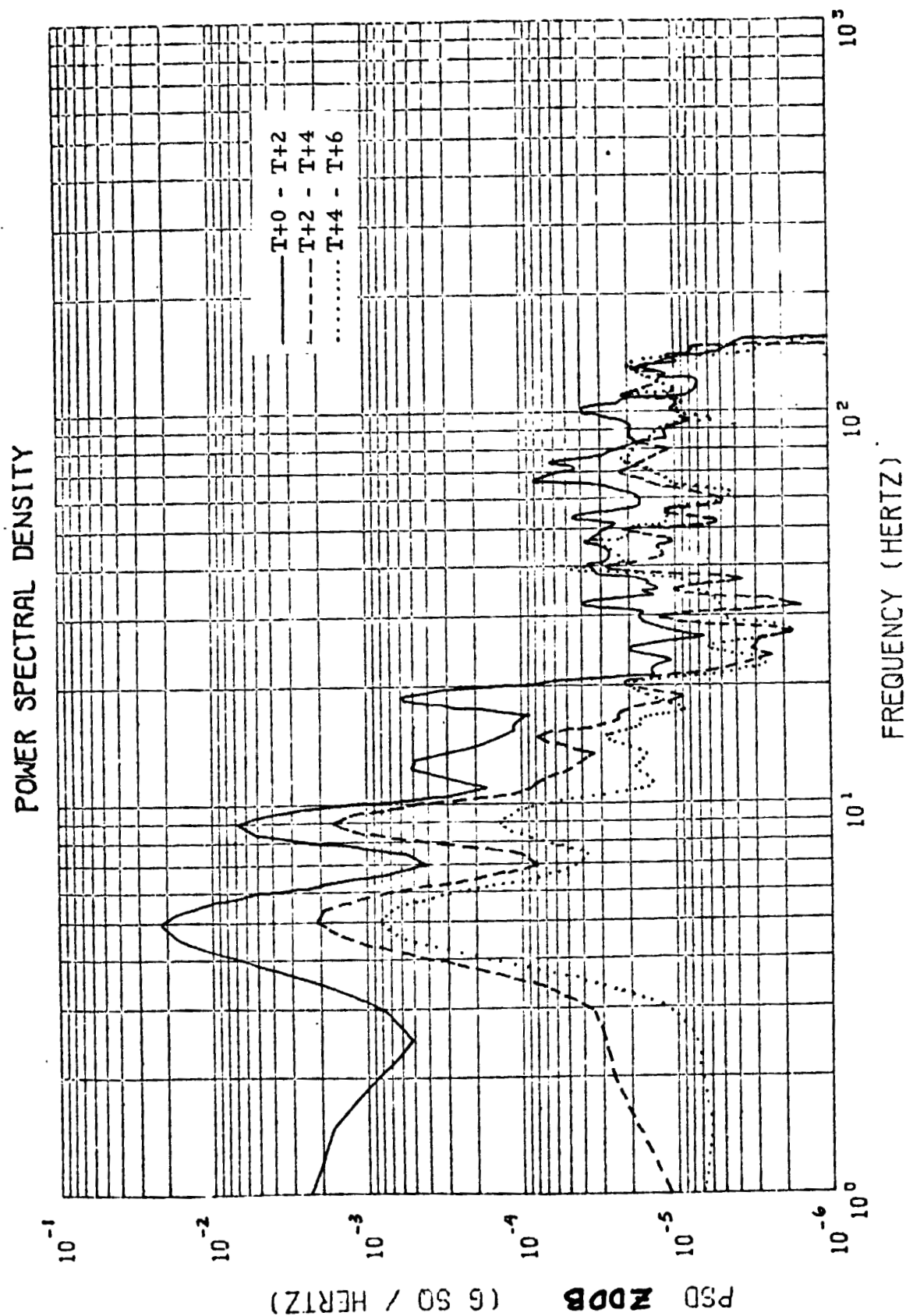


Figure 1.40 TC-4 Viking A - Stage 0 Ignition Summary ZDDB

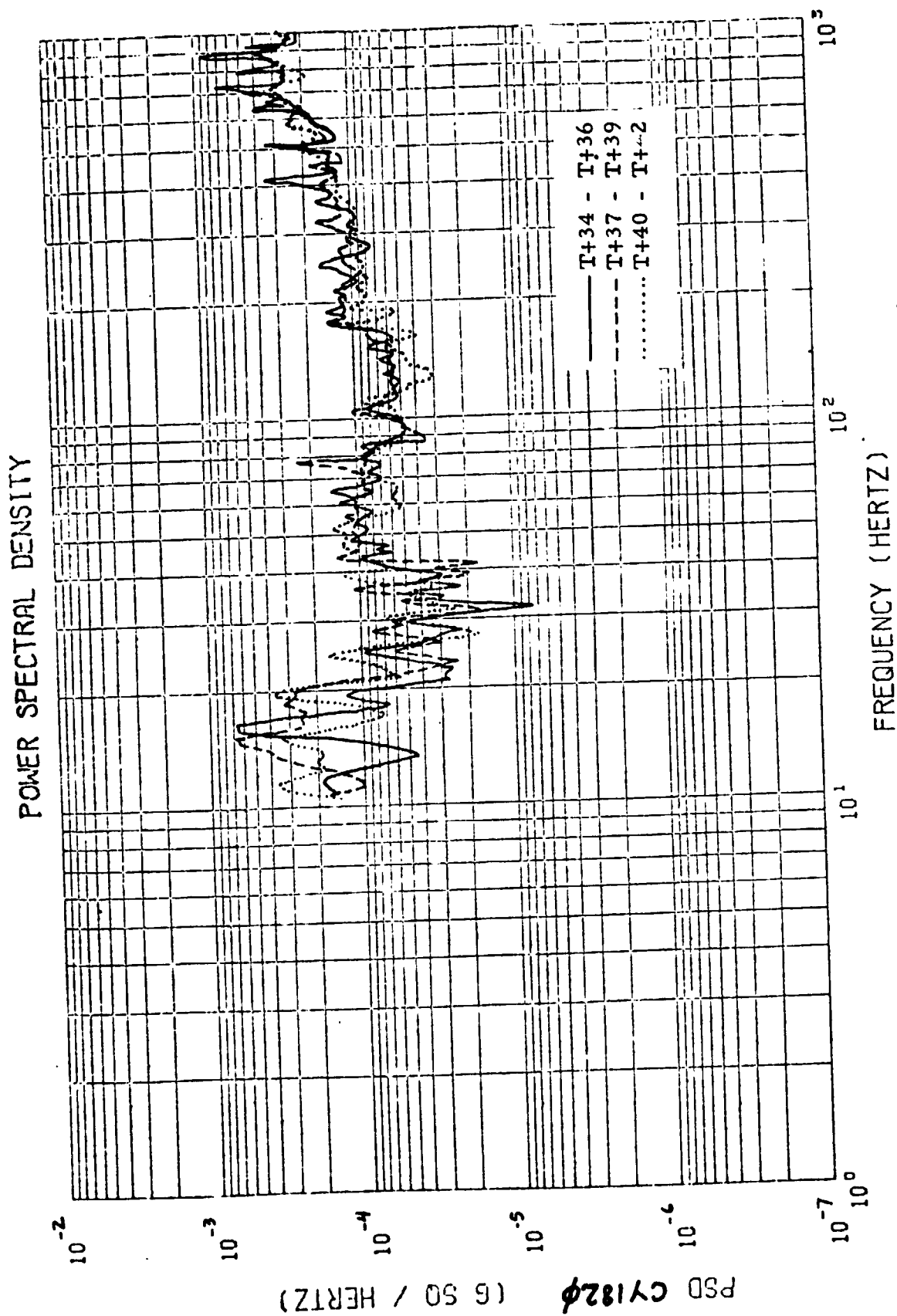


Figure 1.41 TC-4 Viking A Summary Data - CY1820

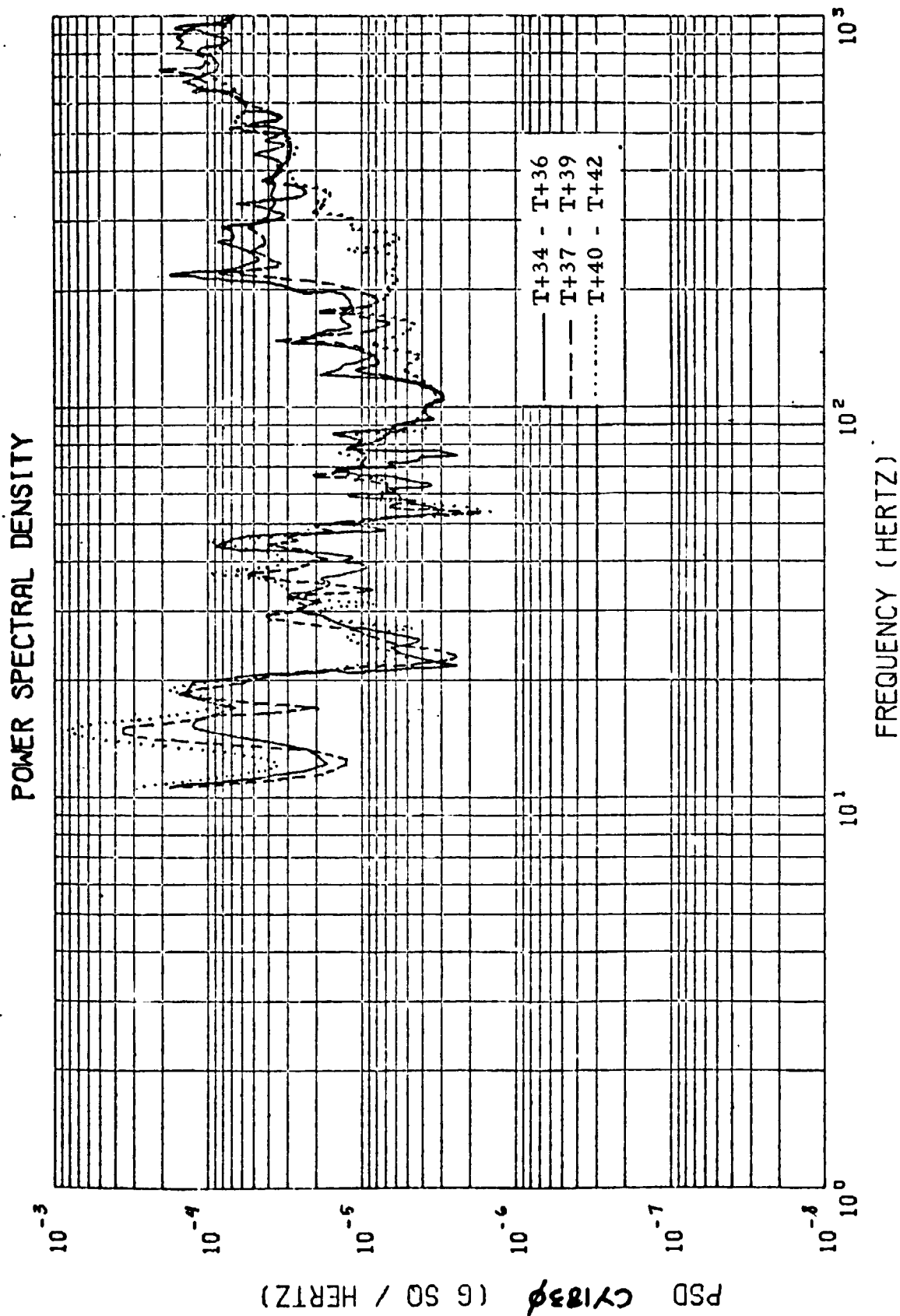


Figure 1.42 TC-4 Viking A Max Q Summary CY1830

POWER SPECTRAL DENSITY

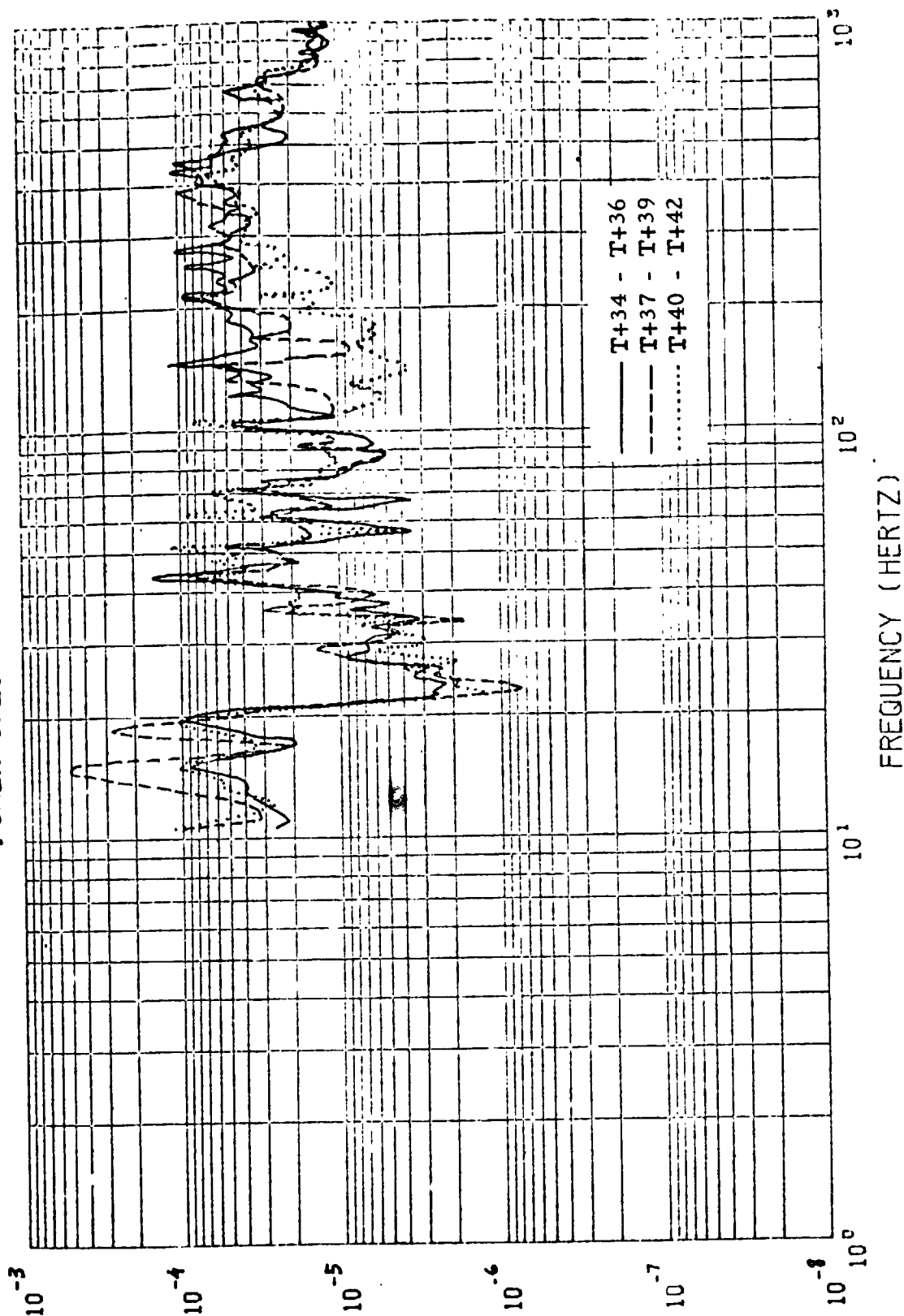


Figure 1.43 TC-4 Viking A Max Q Summary CY1840

POWER SPECTRAL DENSITY

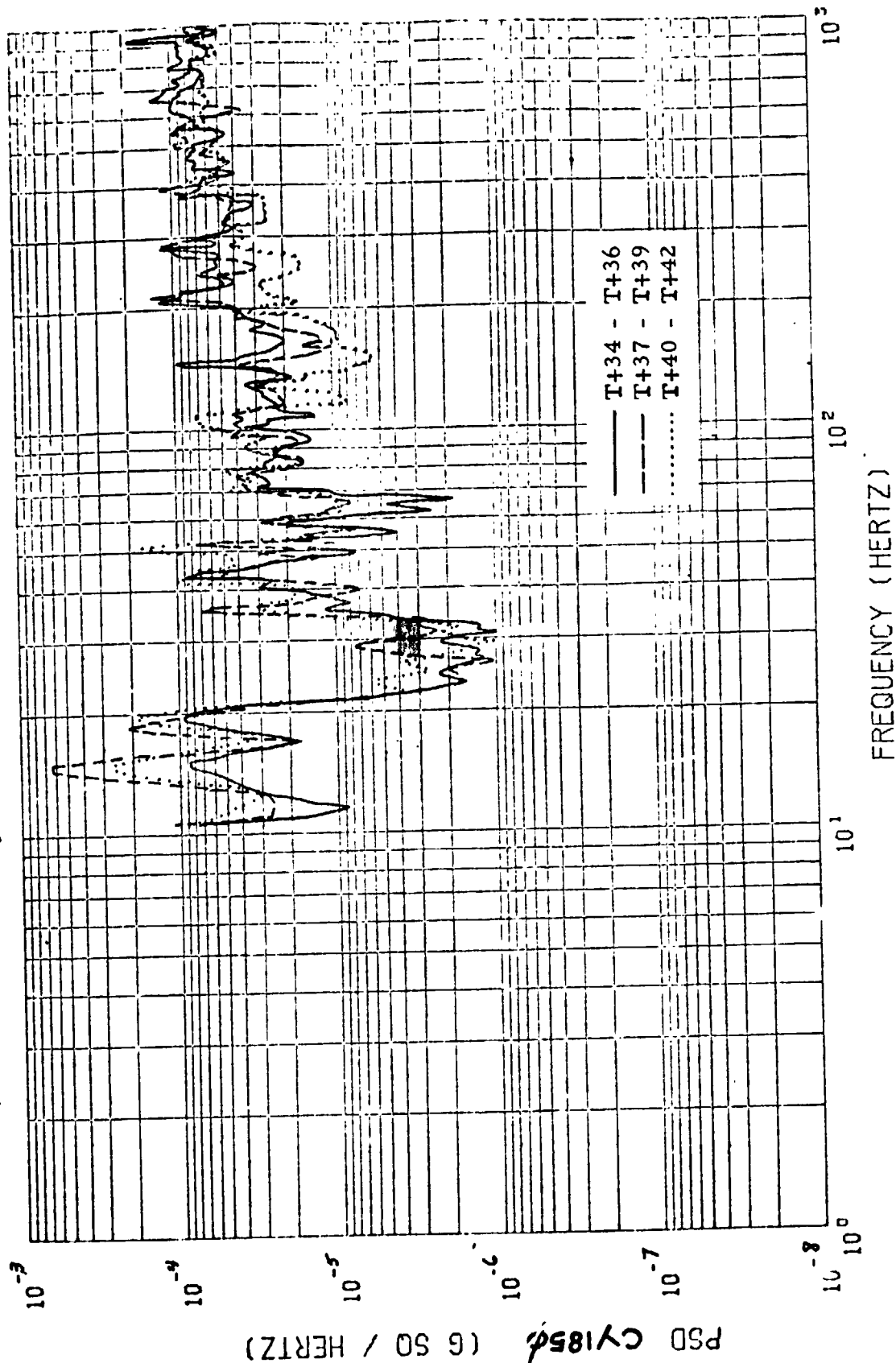


Figure 1.44 TC-4 Viking A Max Q Summary - CY1850

POWER SPECTRAL DENSITY

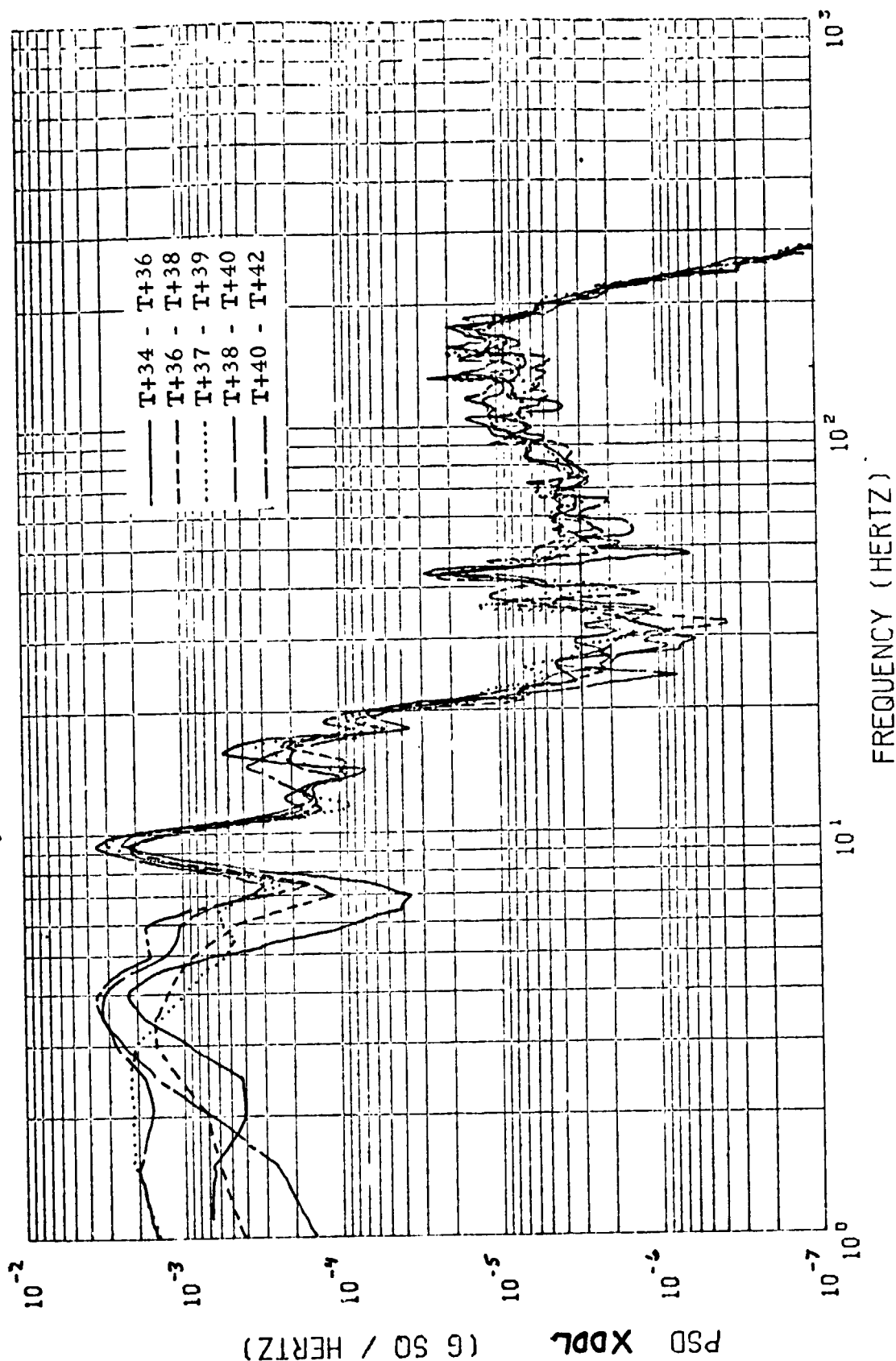


Figure 1.45 TC-4 Viking A Max Q Summary XDDL

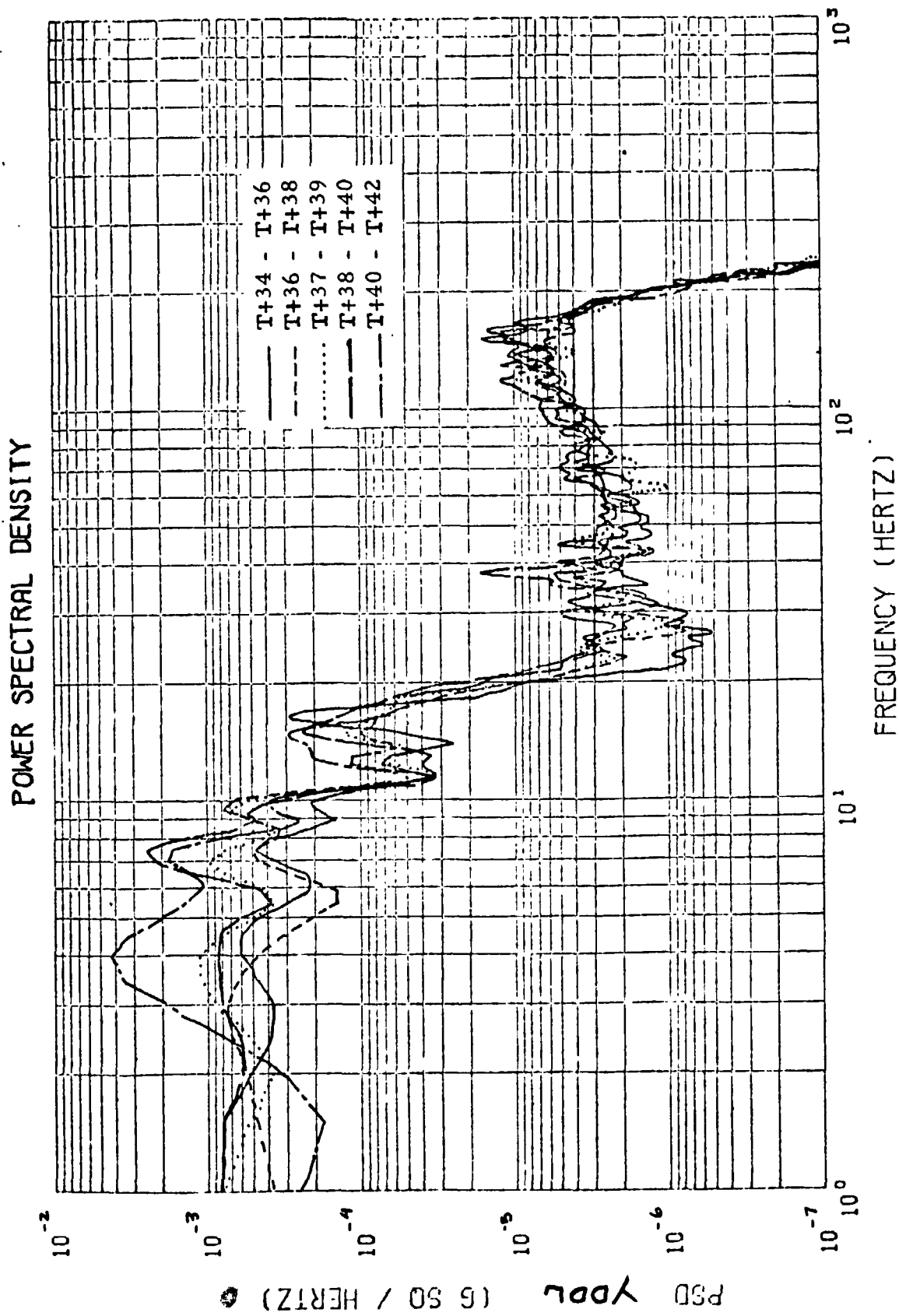


Figure 1.46 TC-4 Viking A Max Q Summary YDDL

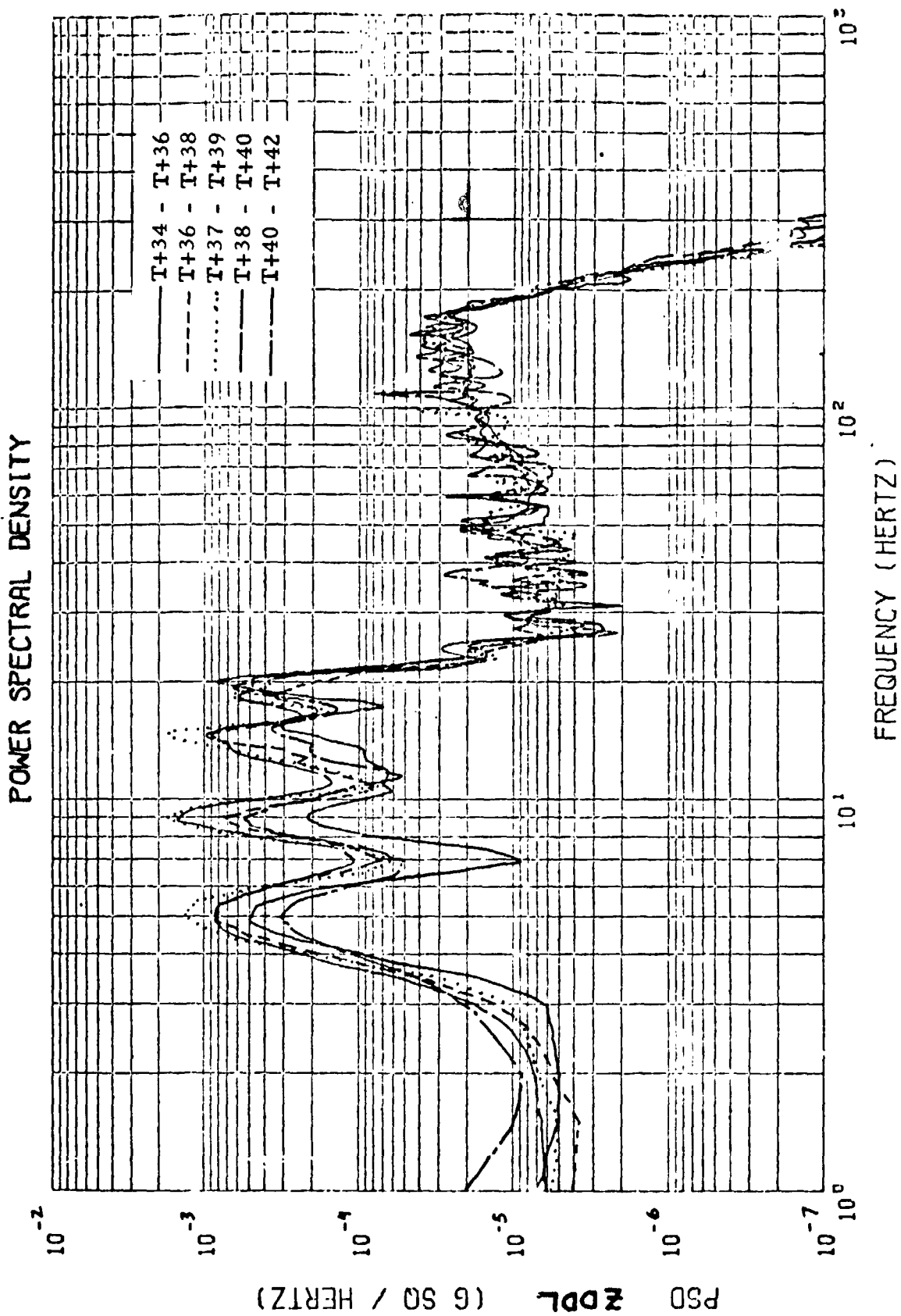


Figure 1.47 TC-4 Viking A Max Q Summary - ZDDL

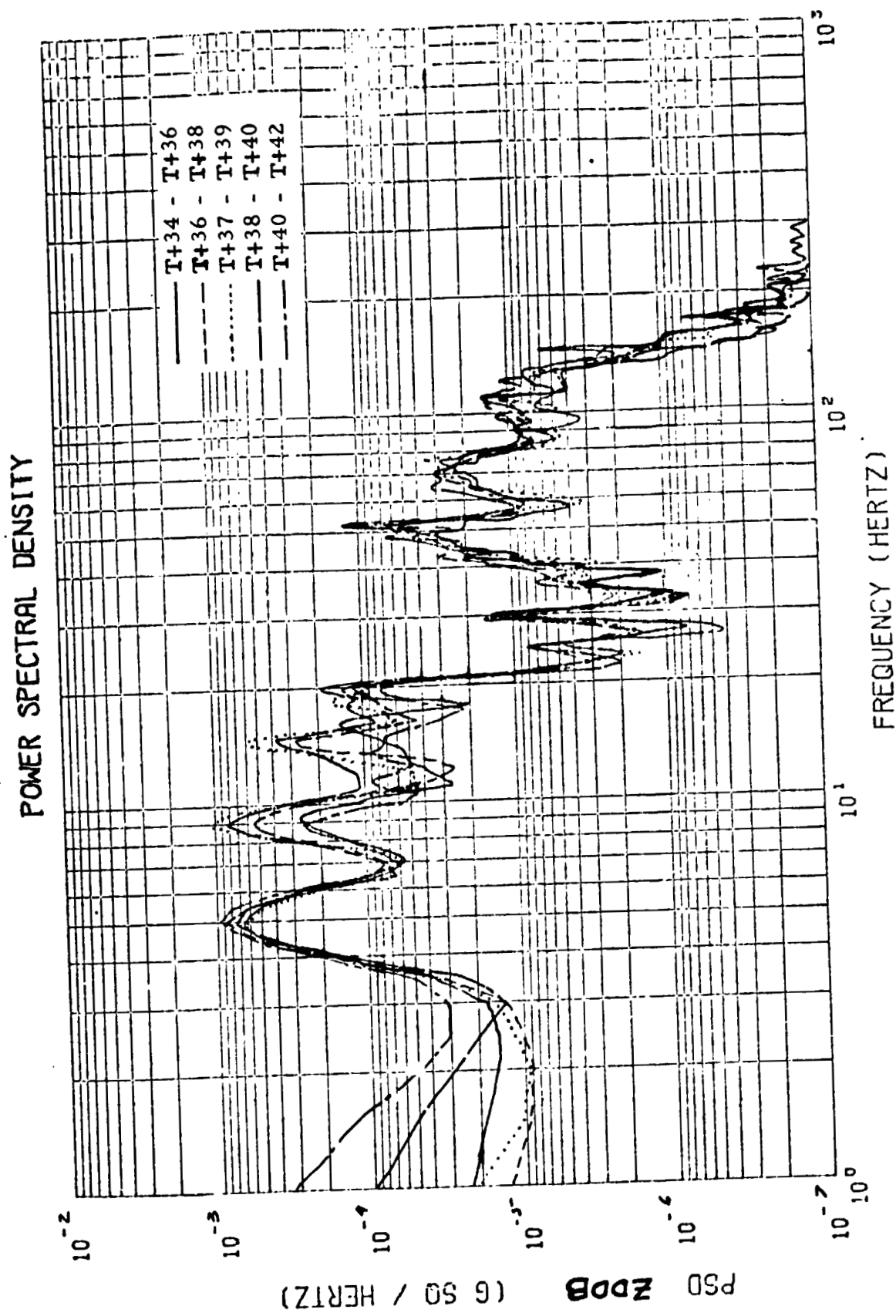


Figure 1.48 TC-4 Viking A Max Q Summary - ZDDB

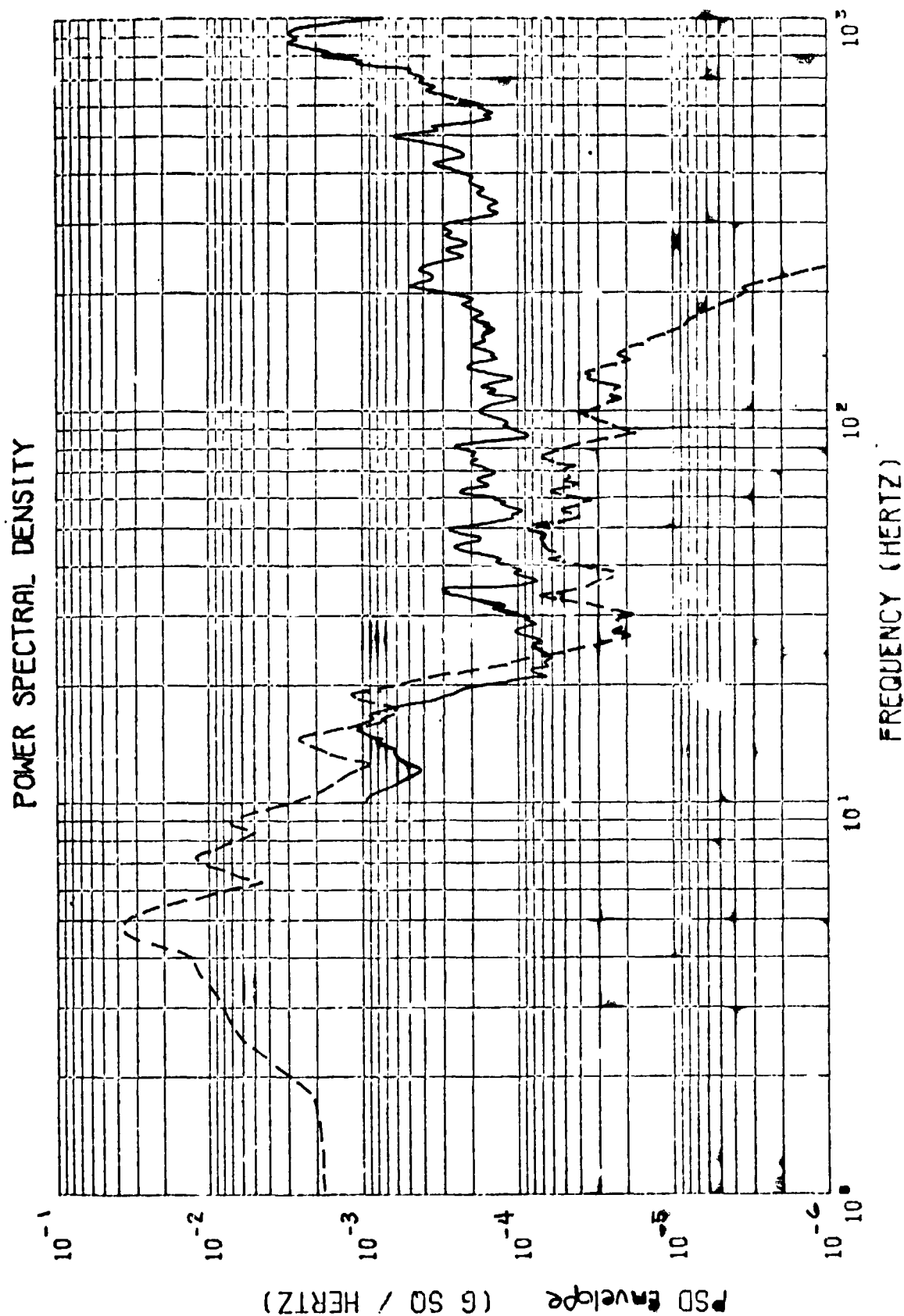
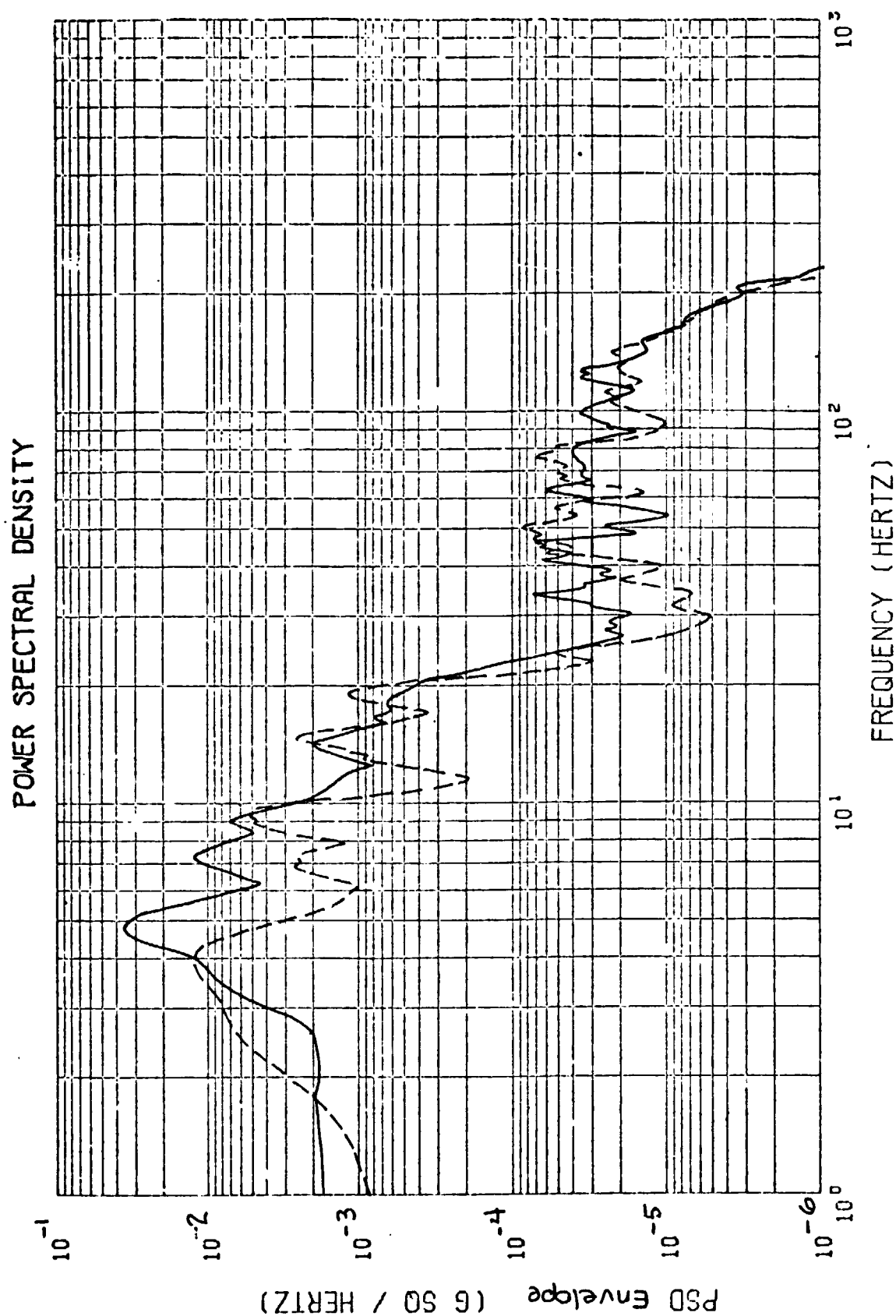


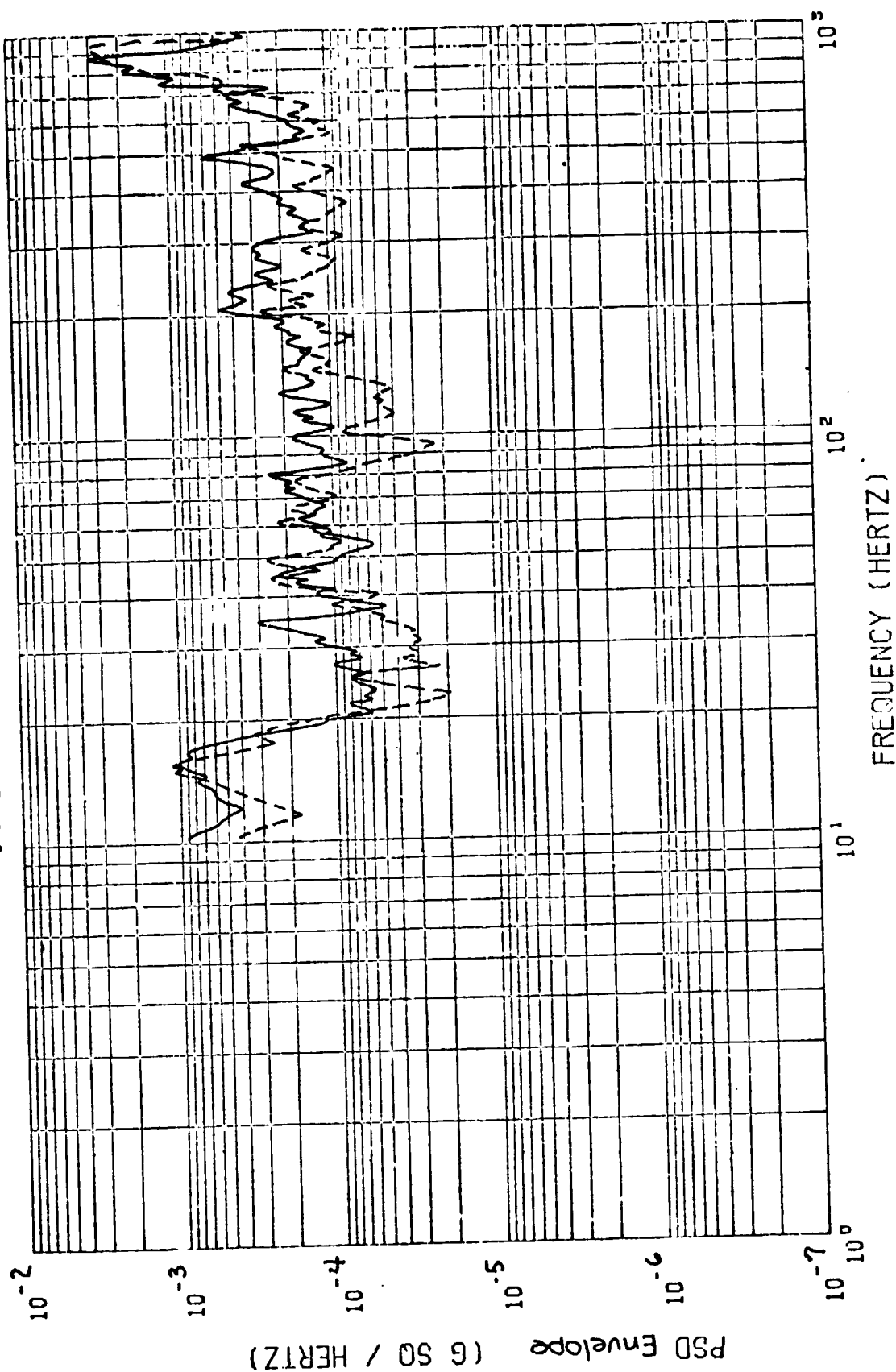
Figure 1.49 TC-3 Viking B Summary PSD Data



Envelopes of Composite Stage 0 Ignition & Composite Max Q PSD

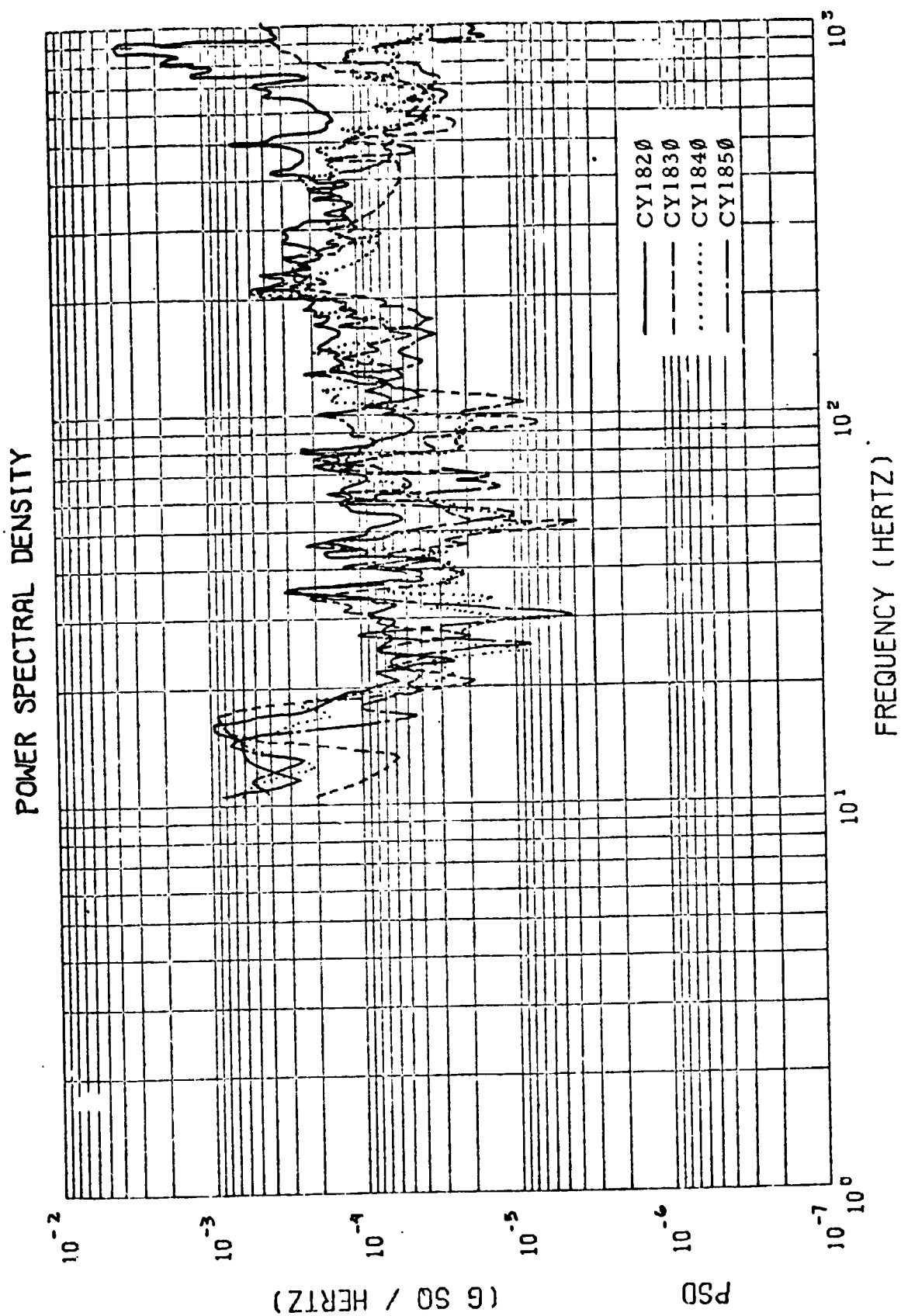
Figure 1.50 - TC-3 Viking B Summary Data - Bus Accelerometers

POWER SPECTRAL DENSITY



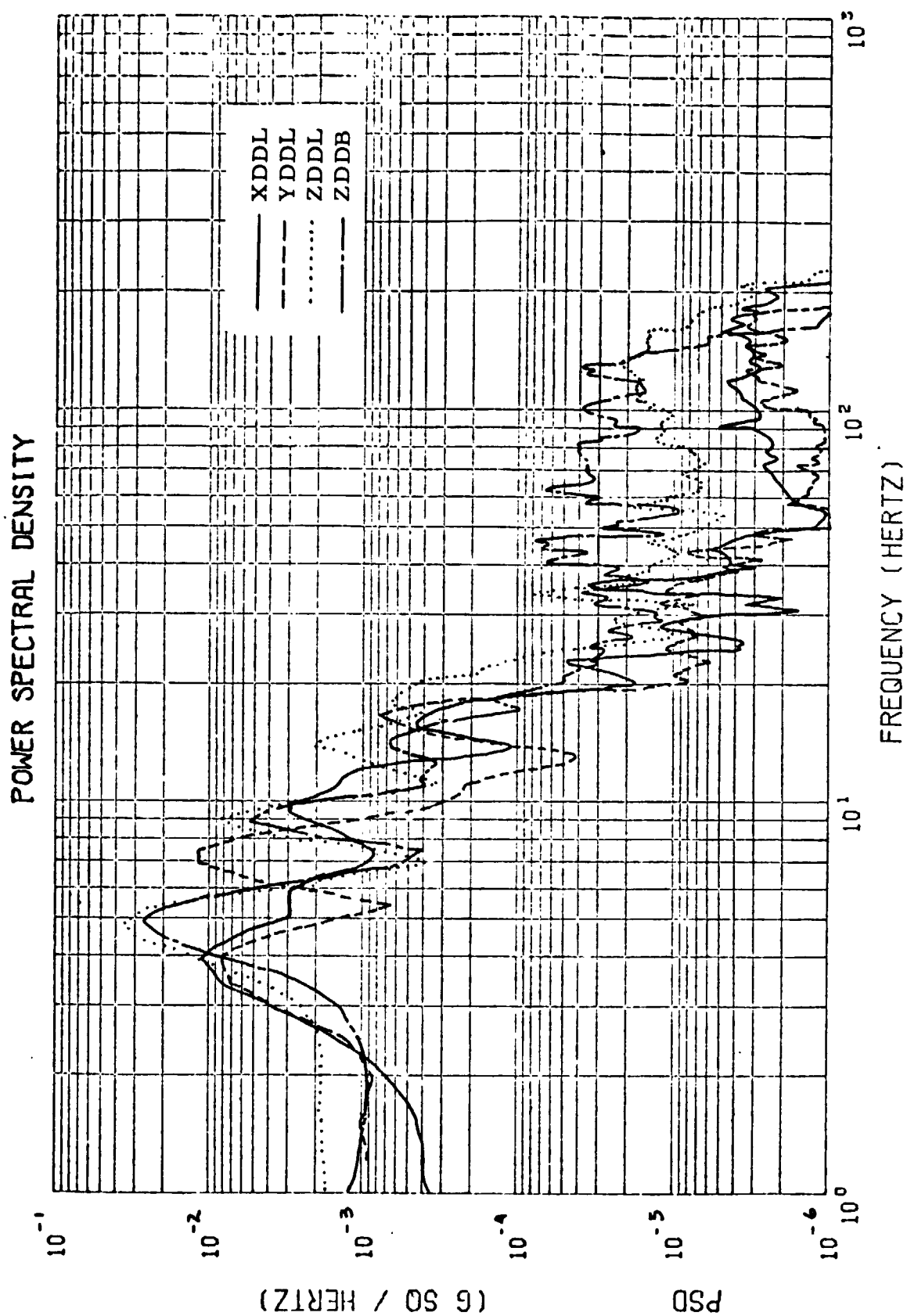
Envelopes of Composite Stage 0 Ignition & Composite Max Q PSD

Figure 1.51 TC-3 Viking B Summary Data - VLC cg Accelerations



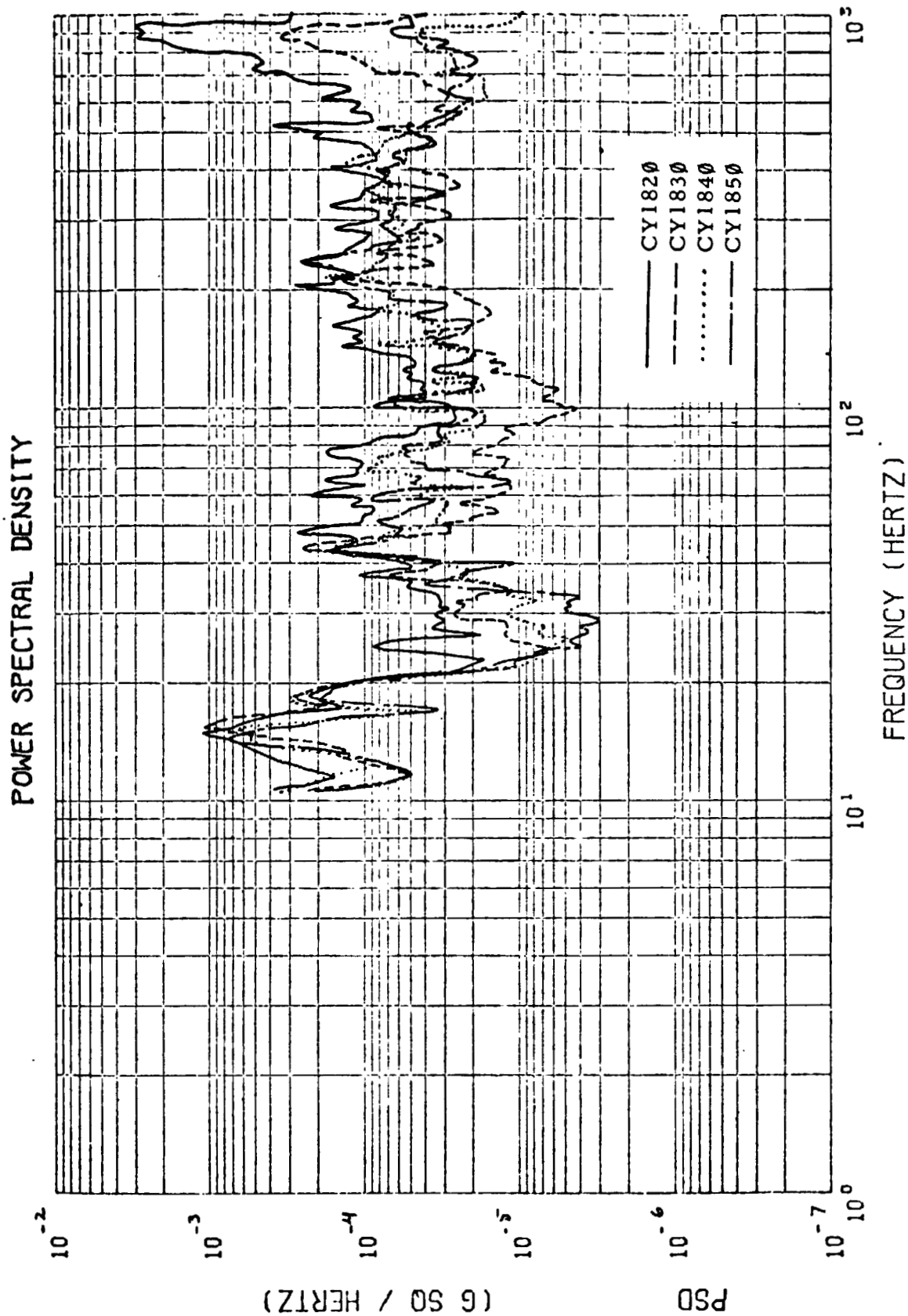
Envelopes of Stage 0 Ignition Composites

Figure 1.52 TC-3 Viking B Summary Data Bus Accelerometers



Envelopes of Stage 0 Ignition Composites

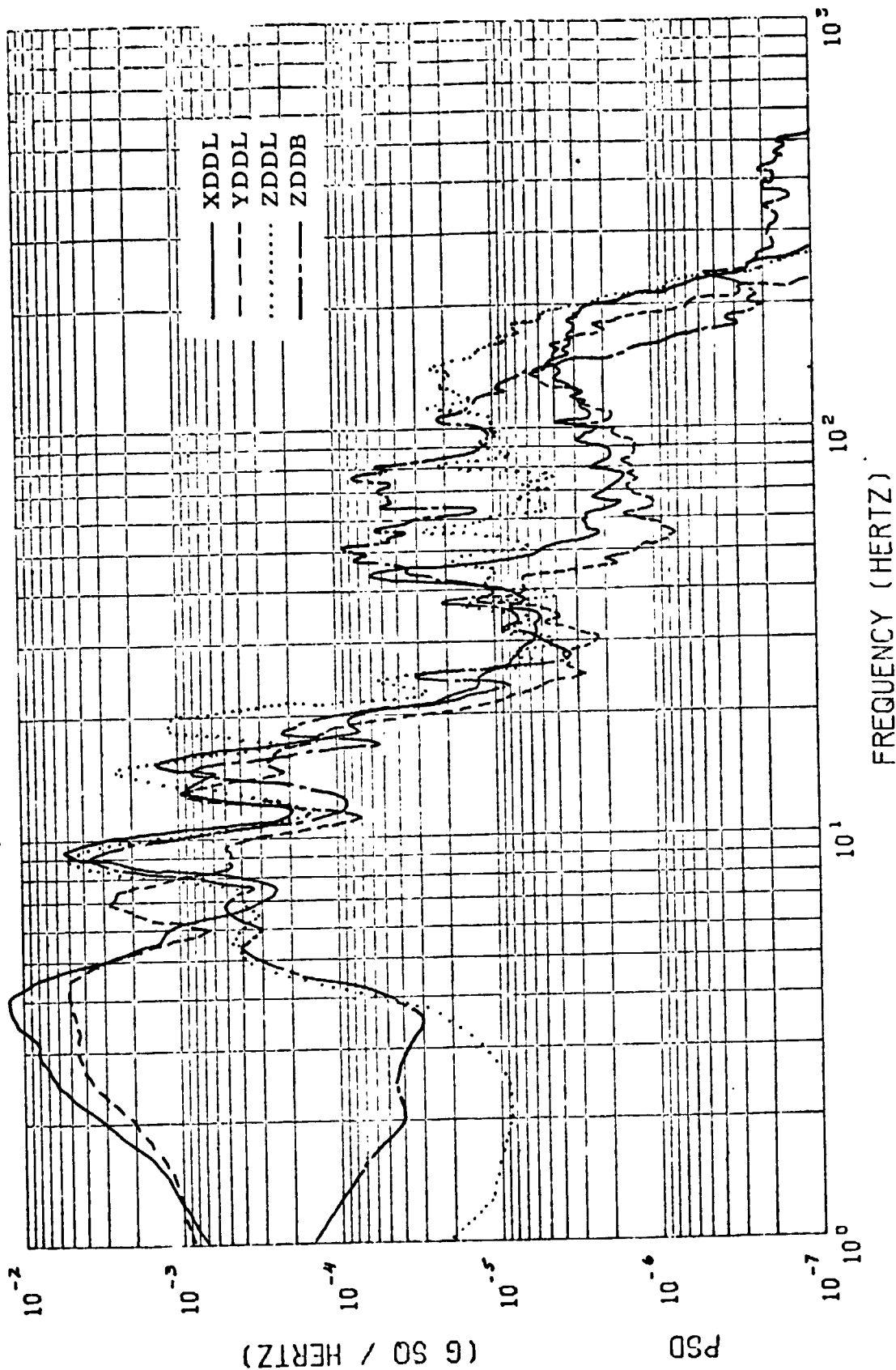
Figure 1.53 TC-3 Viking B Summary Data, VLC cg Accelerations



Envelopes of Max Q Composite Plots

Figure 1.54 TC-3 Viking B Summary Data - Bus Accelerometers

POWER SPECTRAL DENSITY



Envelopes of Max Q Composite Plots

Figure 1.55 TC-3 Viking B Summary Data - VLC cg Accelerations

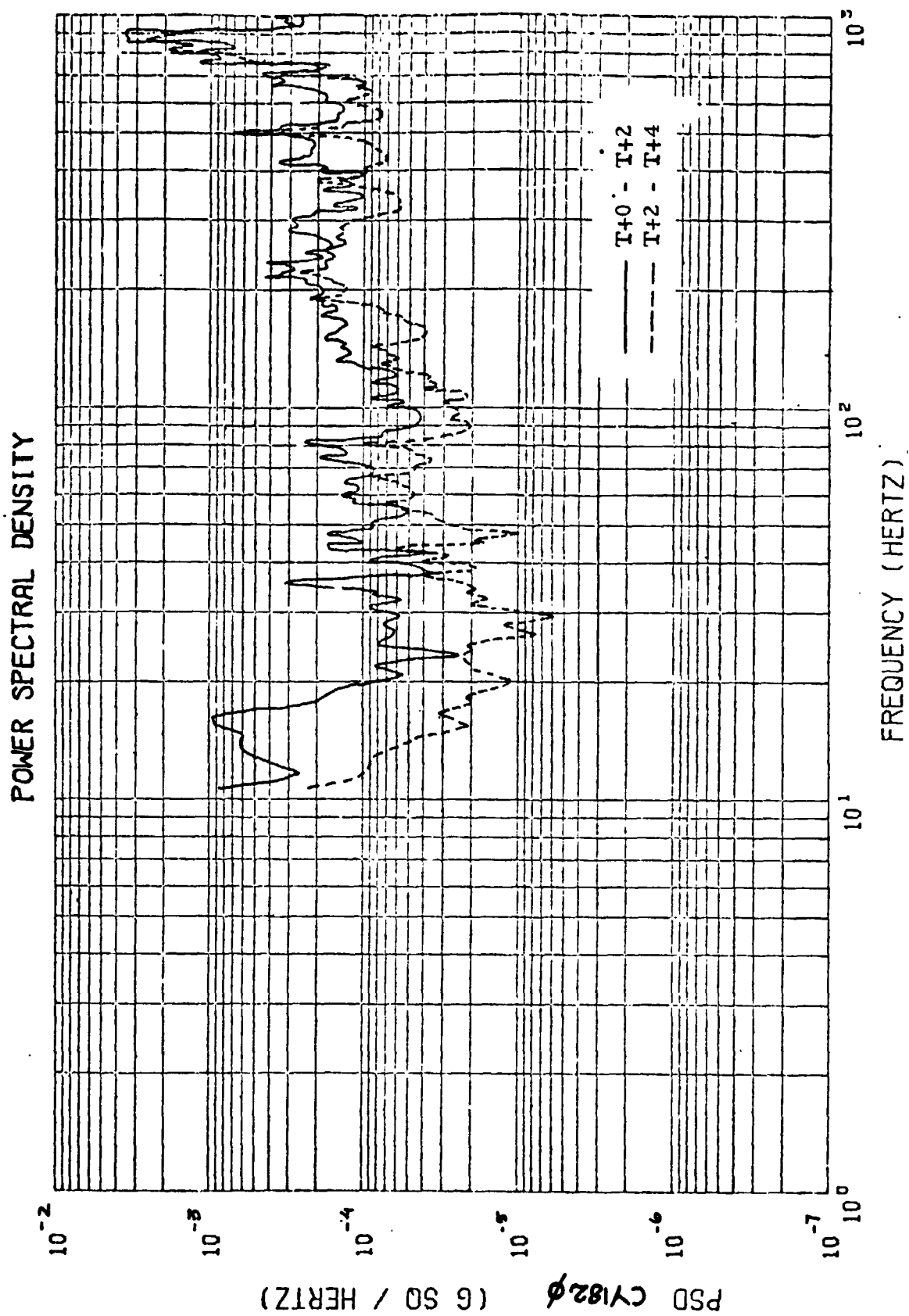


Figure 1.56 TC-3 Viking B Stage 0 Ignition Summary CY1820

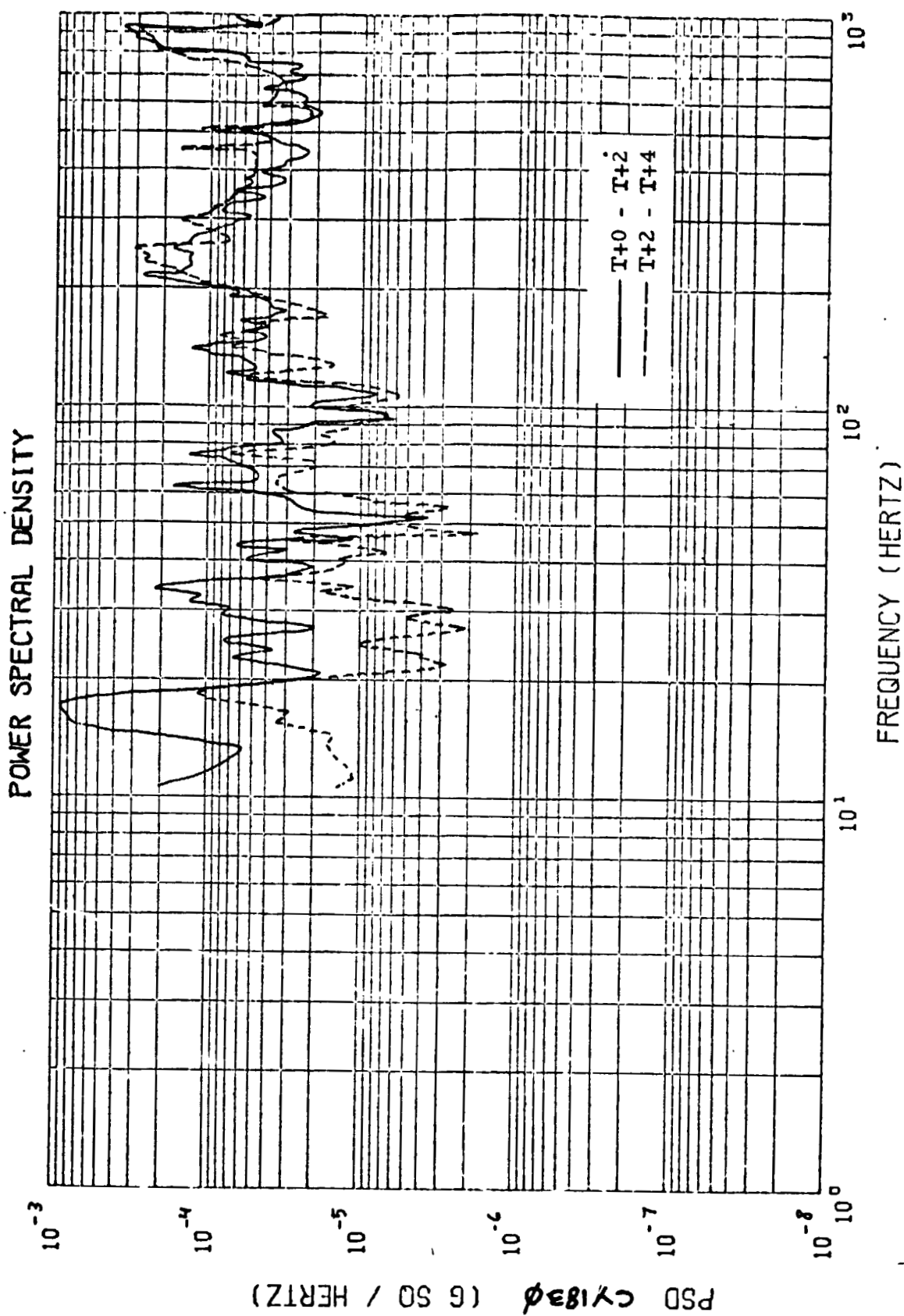


Figure 1.57 TC-3 Viking B Stage 0 Ignition Summary - CY1830

POWER SPECTRAL DENSITY

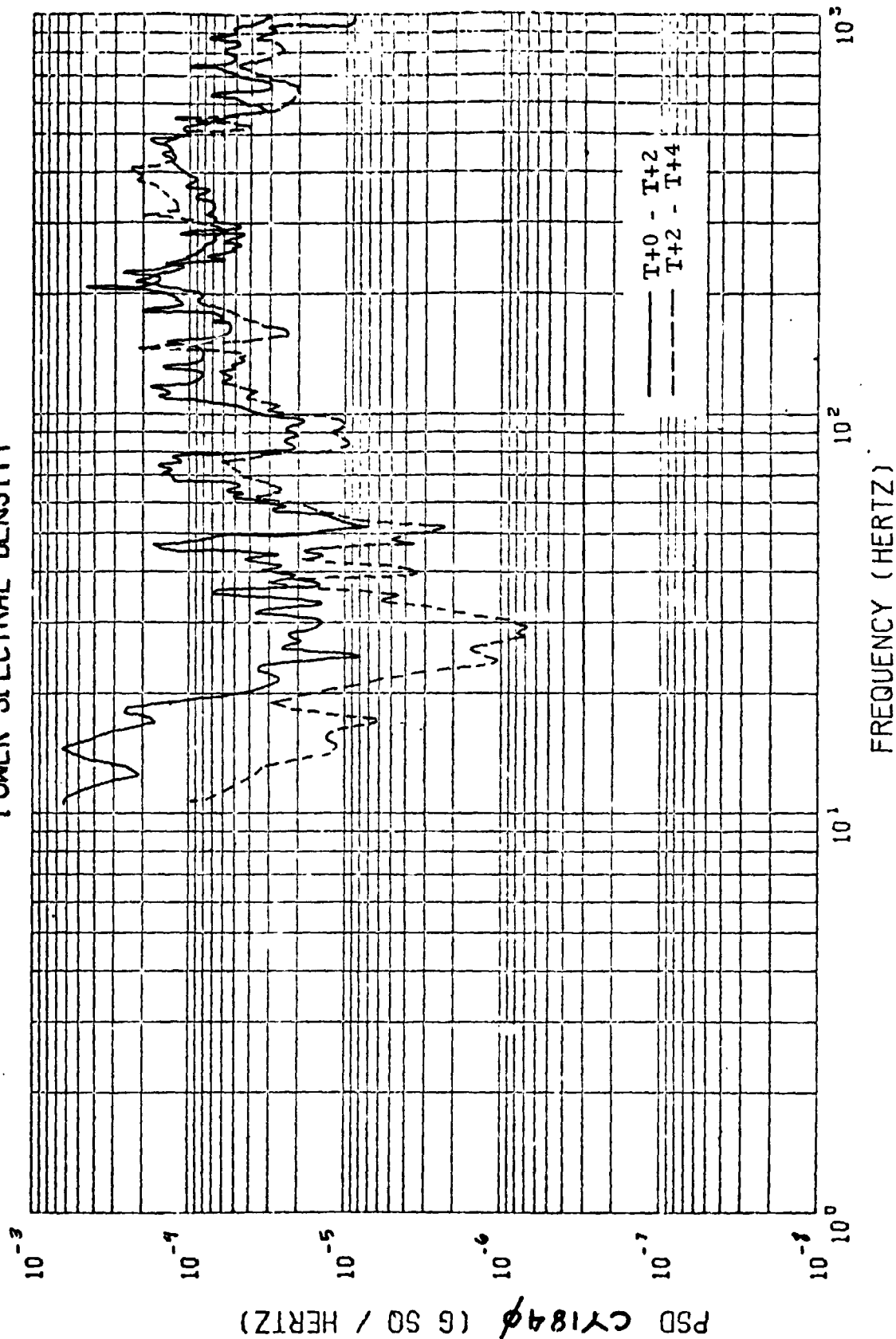


Figure 1.58 TC-3 Viking B Stage 0 Ignition Summary CY1840

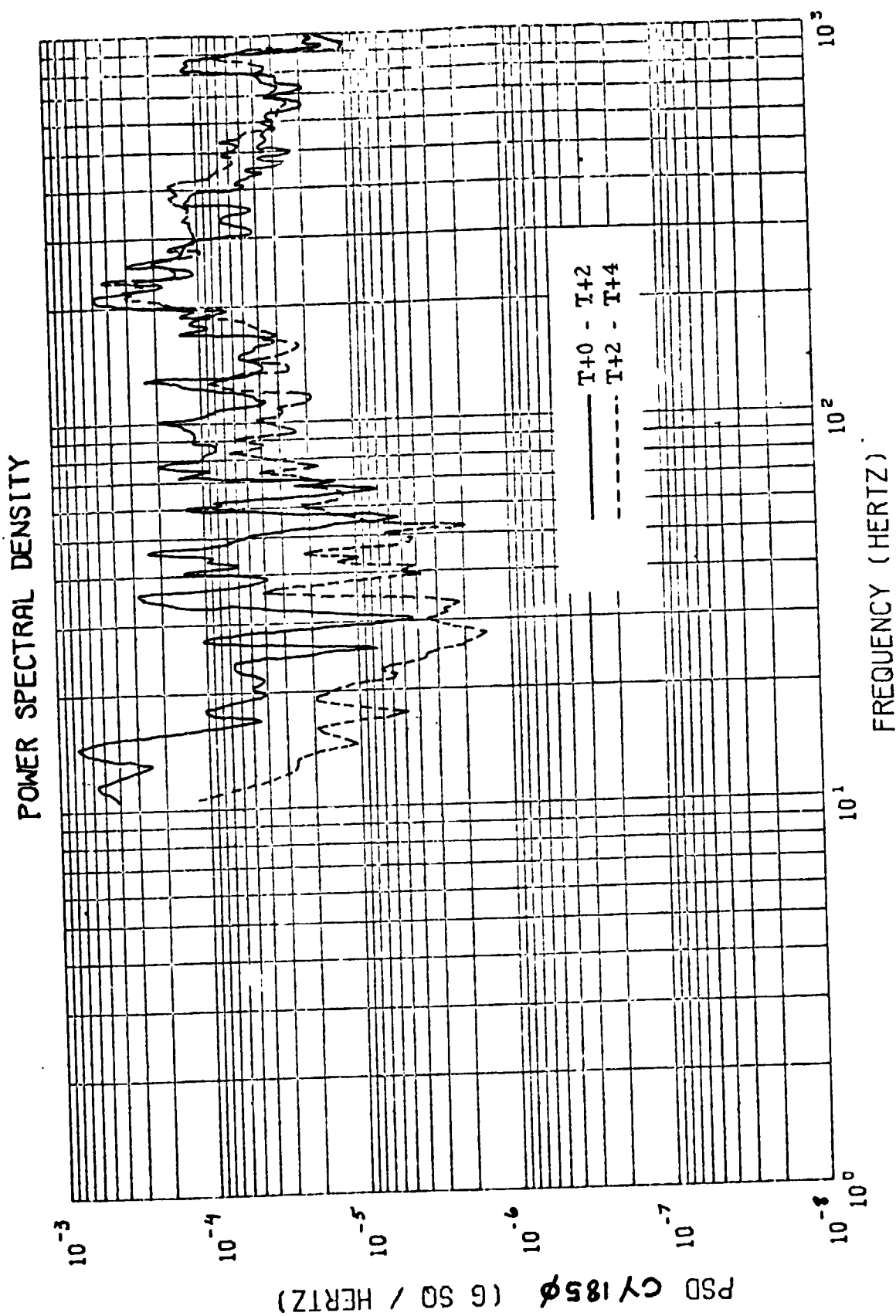


Figure 1.59 TC-3 Viking B Stage 0 Ignition Summary - CY1850

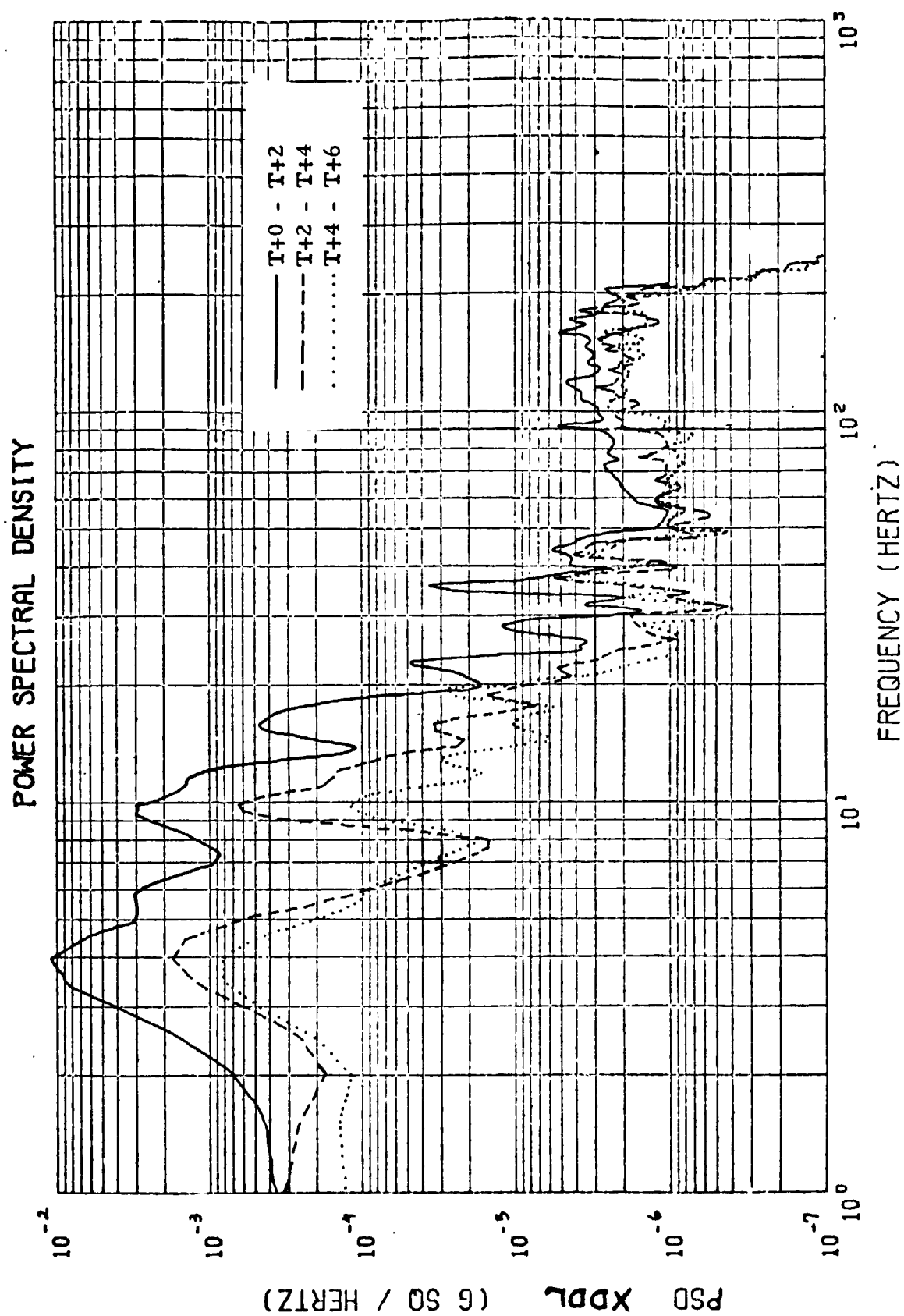


Figure 1.60 TC-3 Viking B Stage 0 Ignition Summary XDDL

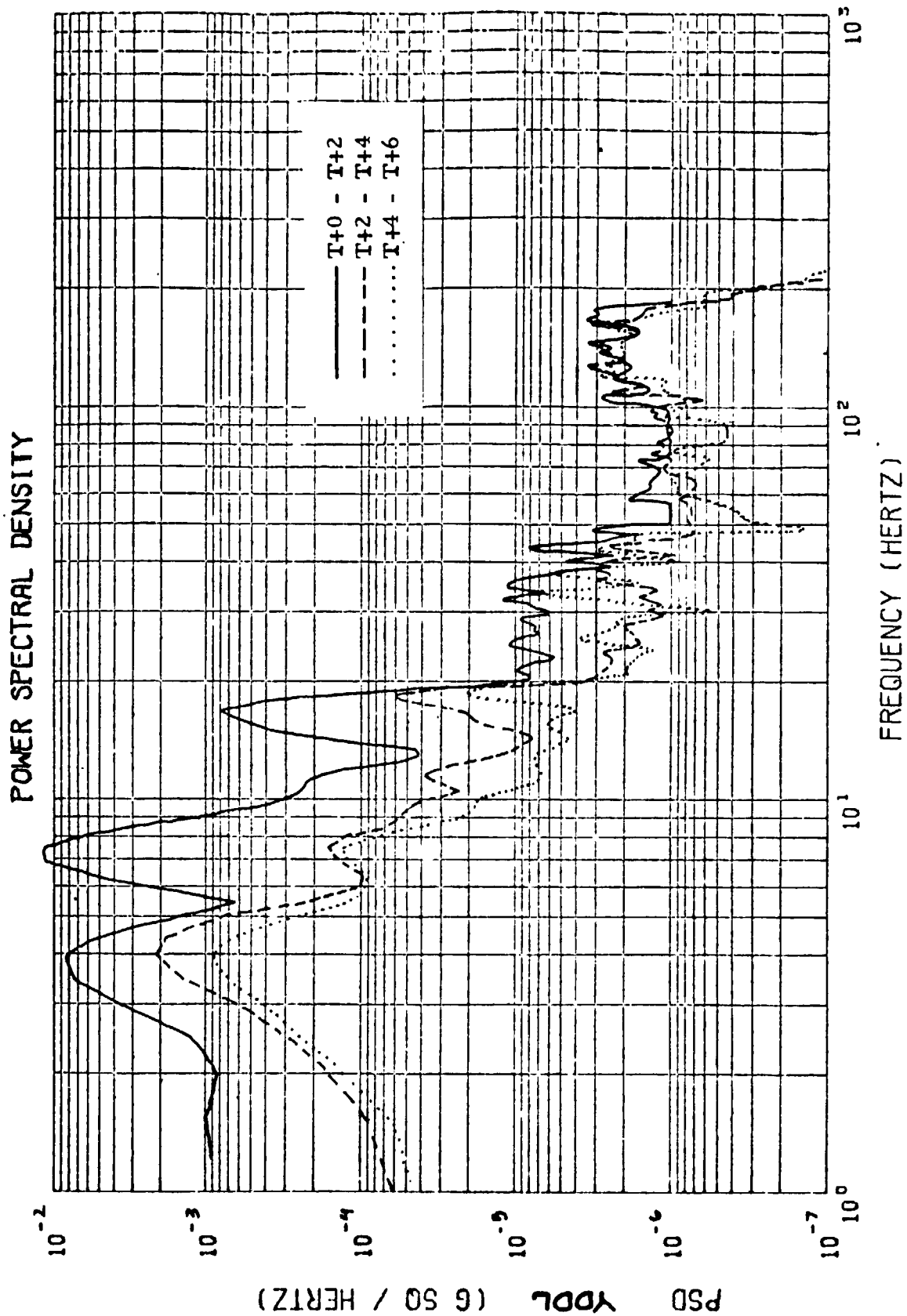


Figure 1.61 TC-3 Viking B Stage 0 Ignition Summary YDDL

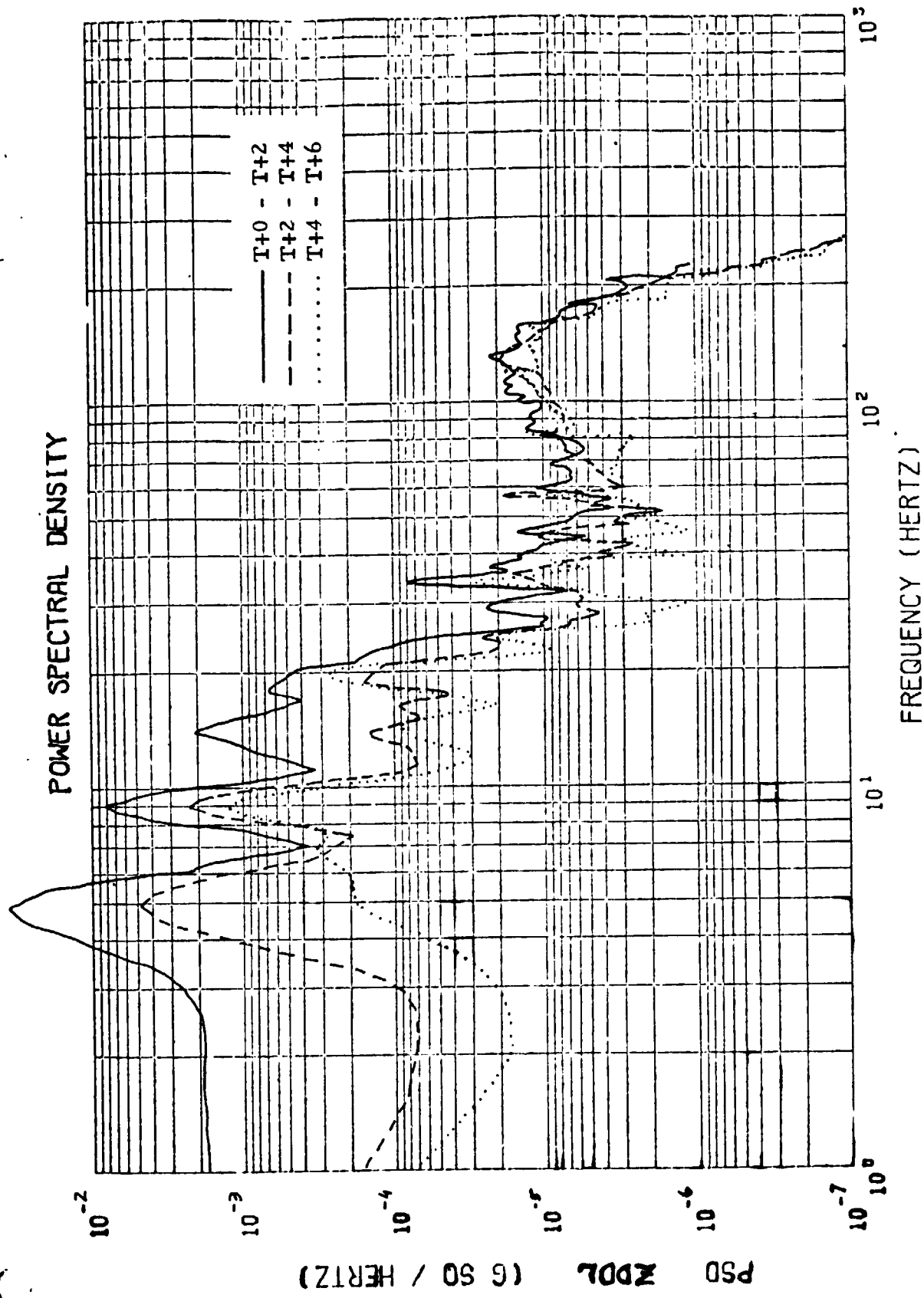


Figure 1.62 TC-3 Viking B Stage 0 Ignition Summary ZDDL

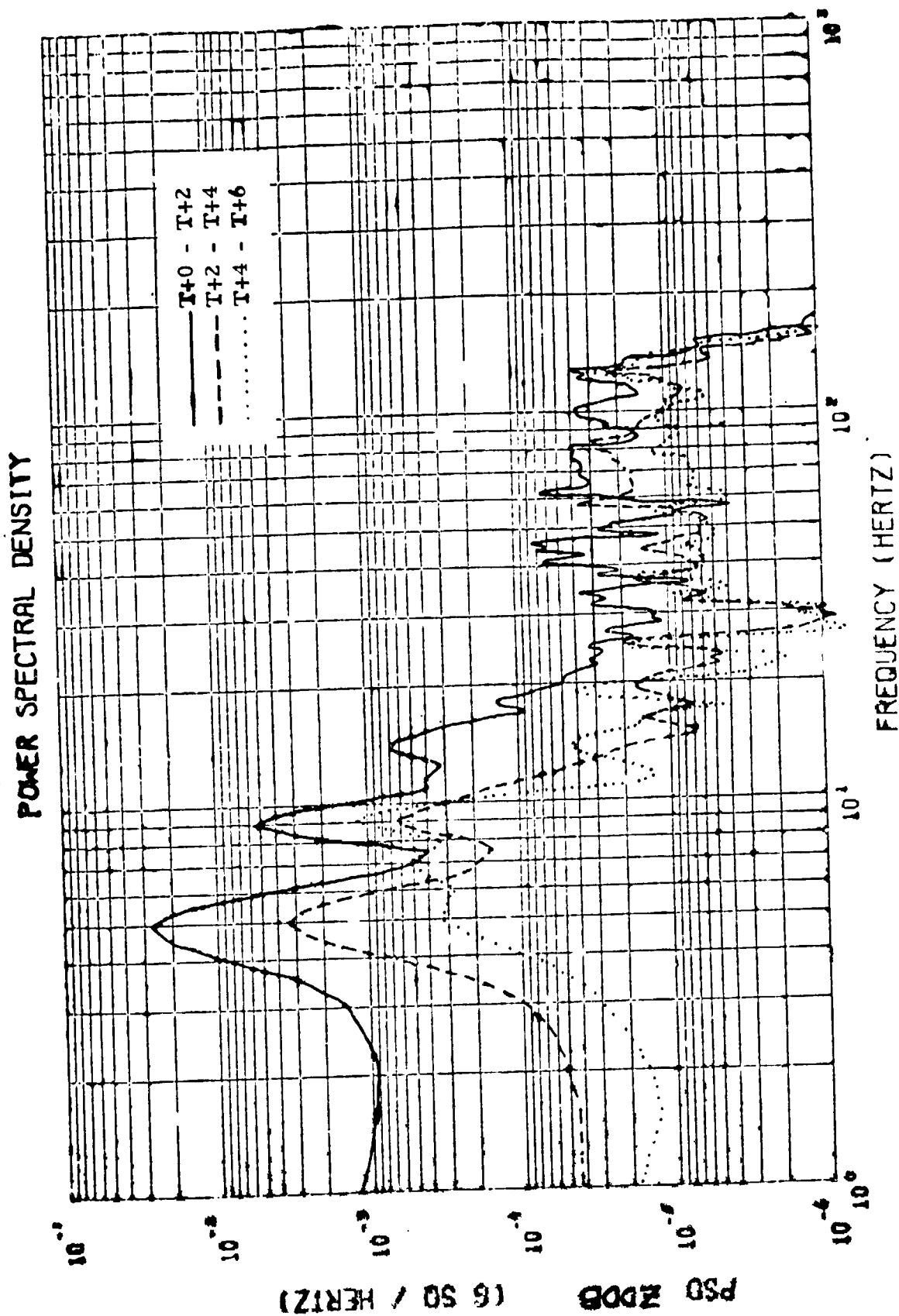


Figure 1.63 TC-3 Viking B - Stage 0 Ignition Summary ZDOB

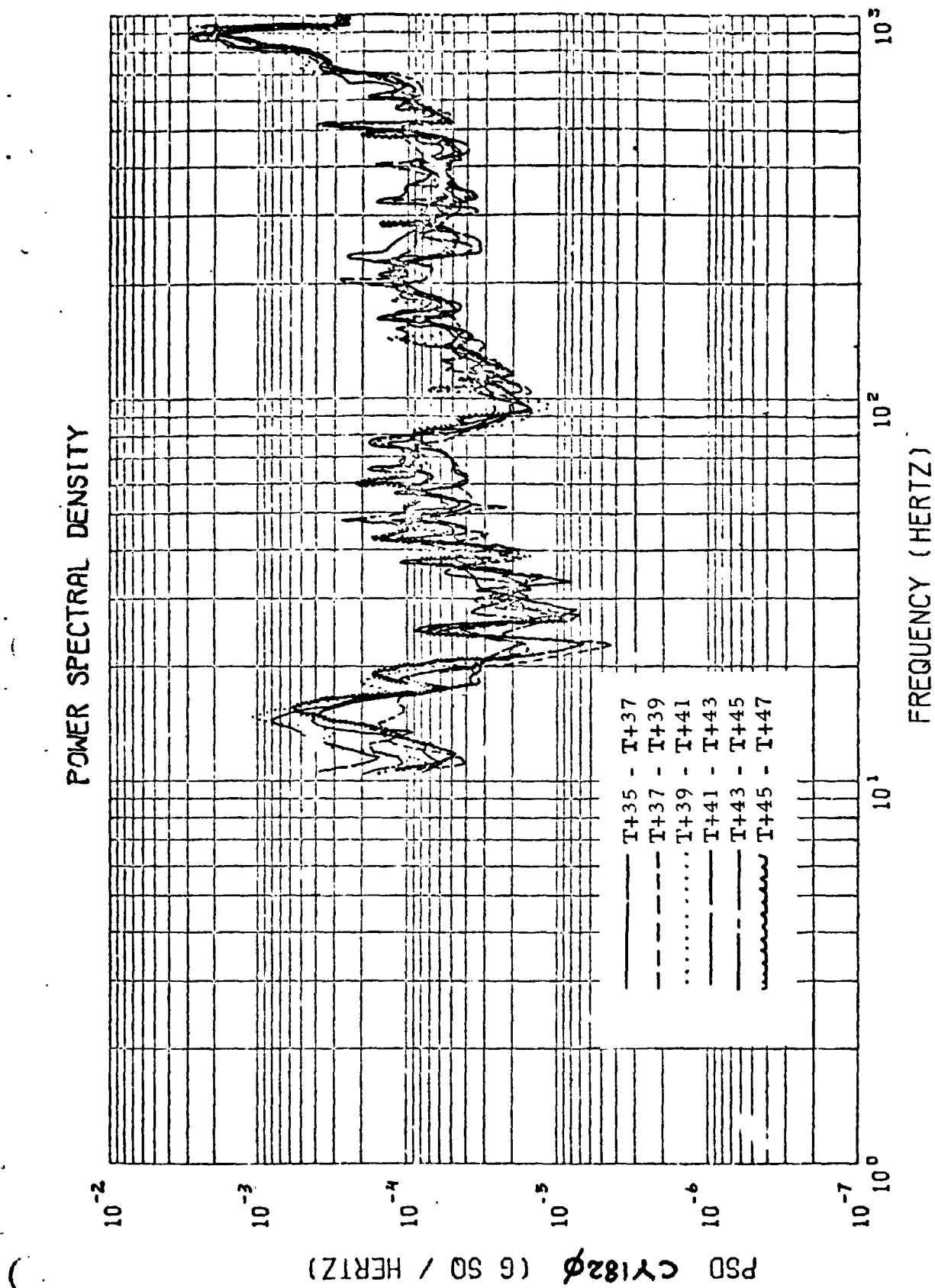


Figure 1.64 TC-3 Viking B Max Q Summary - CY1820

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POWER SPECTRAL DENSITY

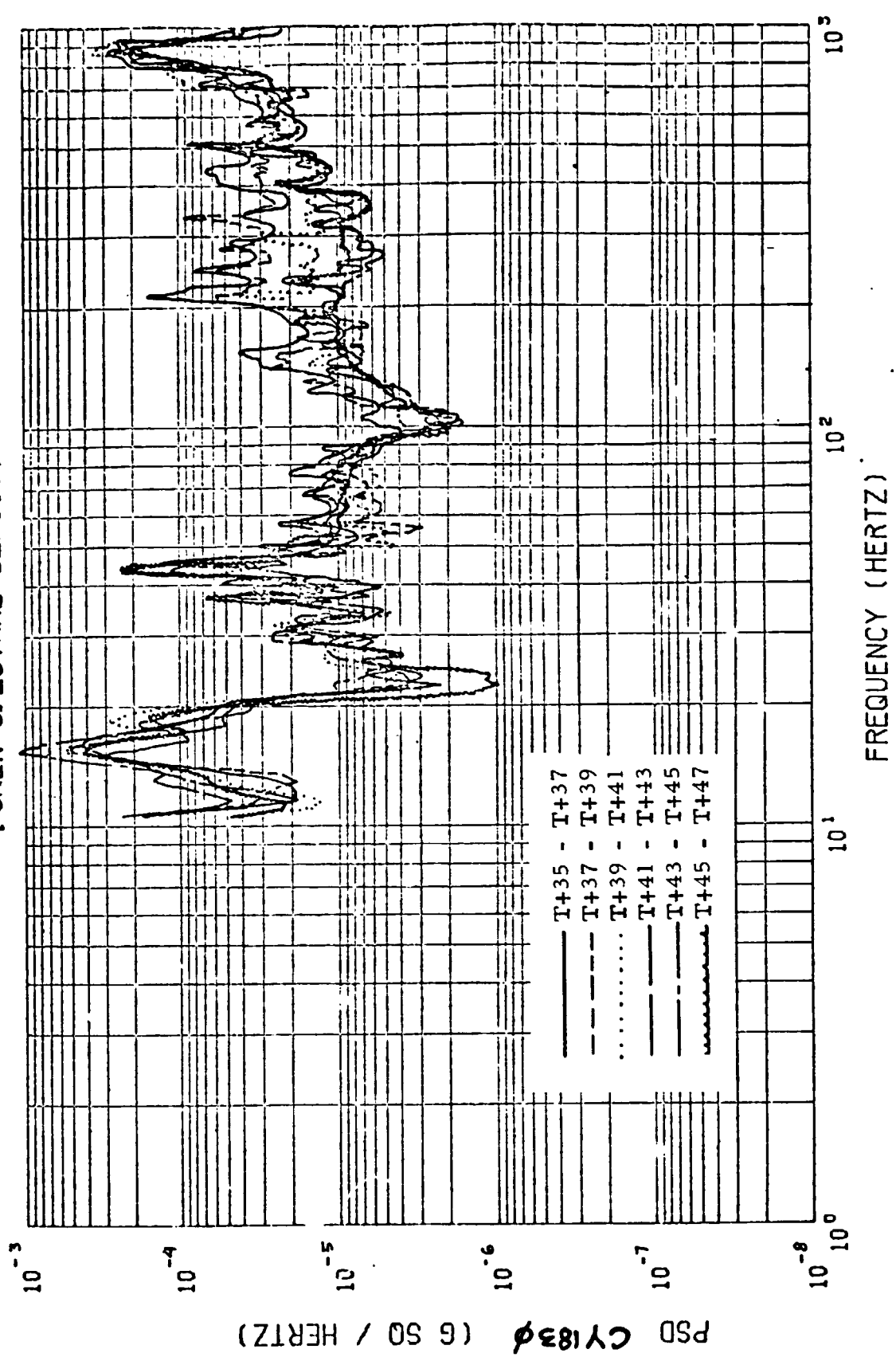


Figure 1.65 TC-3 Viking B Max Q Summary - CV1830

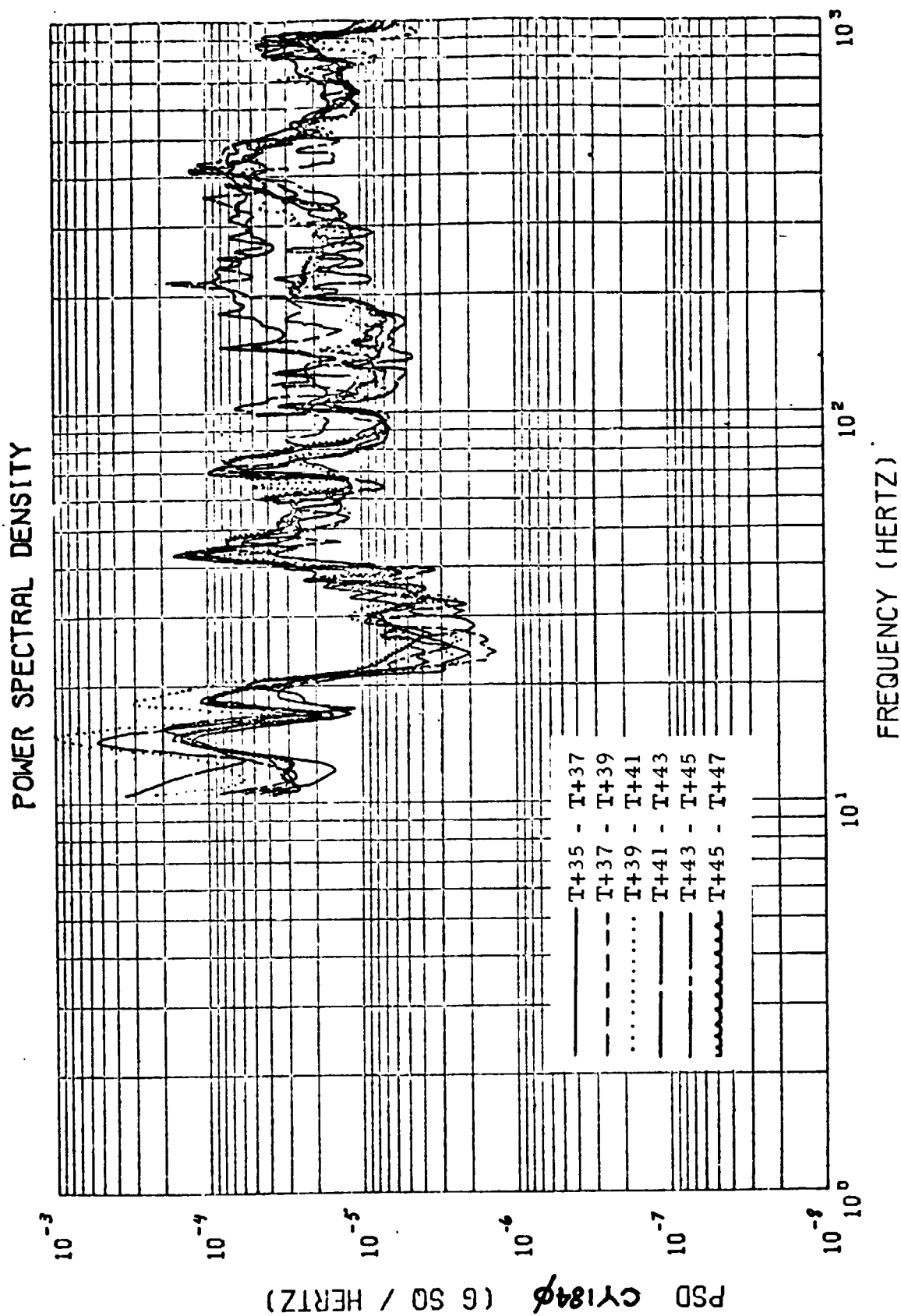


Figure 1.66 TC-3 Viking B Max Q Summary - CY1840

POWER SPECTRAL DENSITY

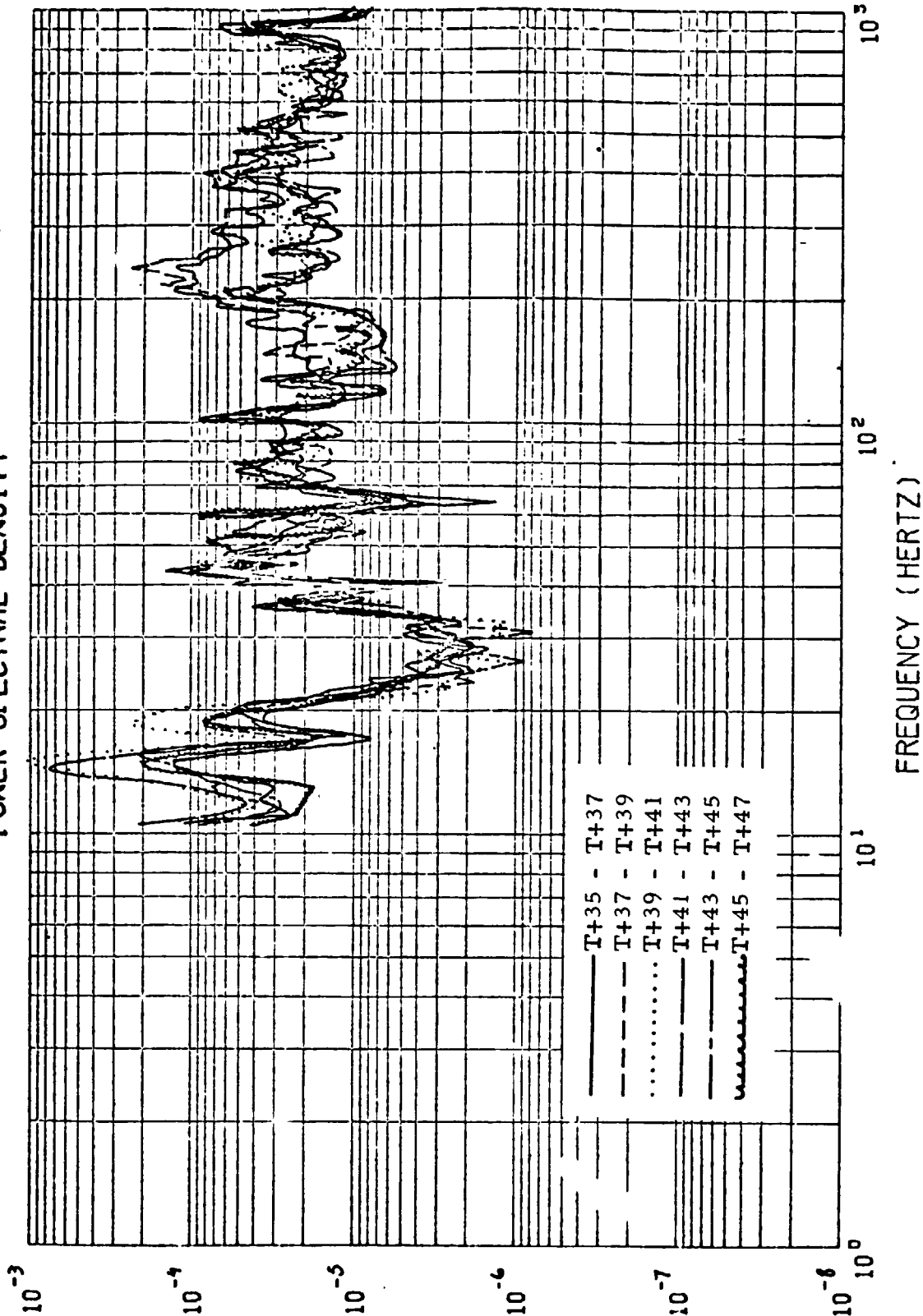


Figure 1.67 TC-3 Viking B Max Q Summary CY1850

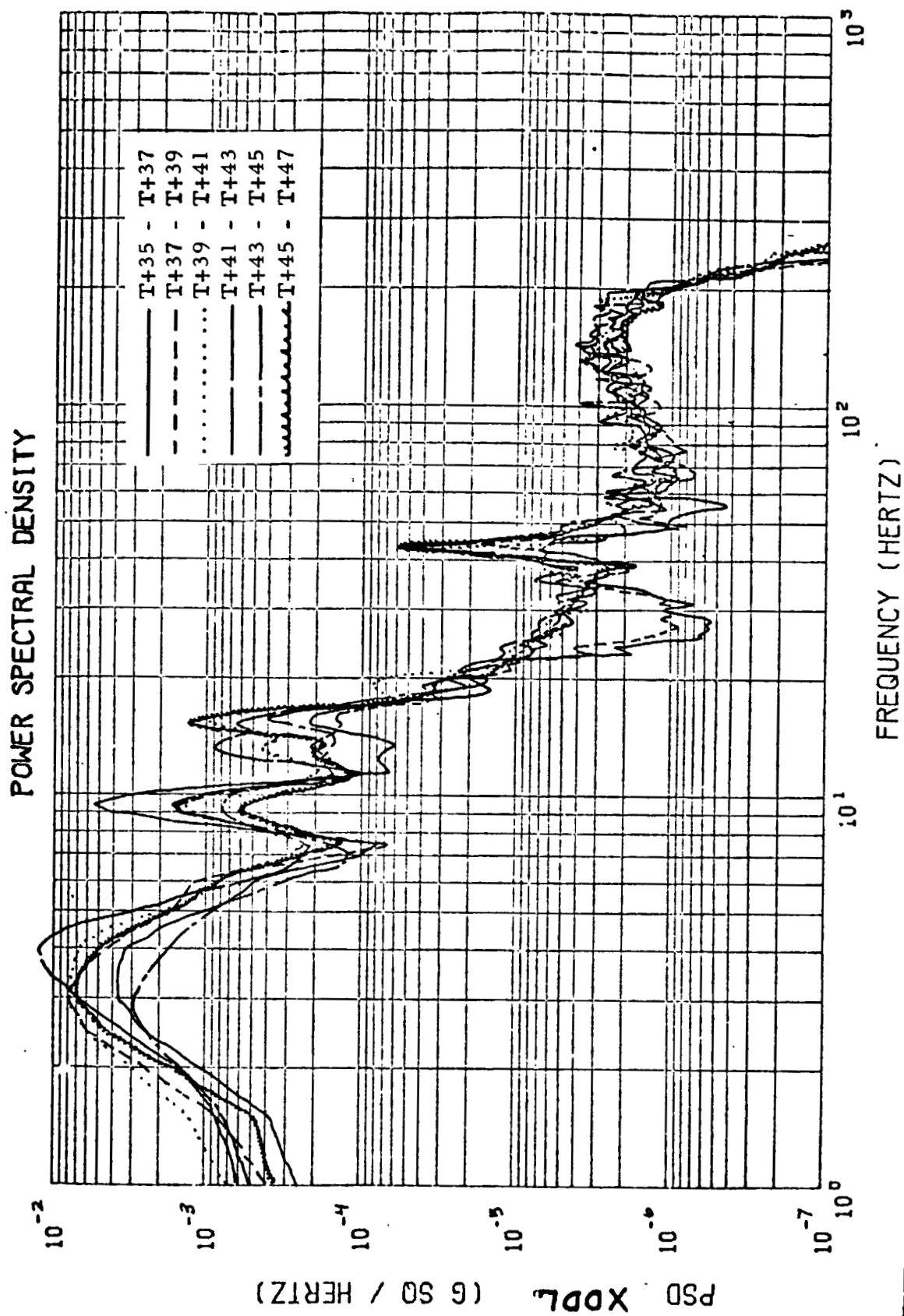


Figure I.68 TC-3 Viking B Max Q Summary - XDDL

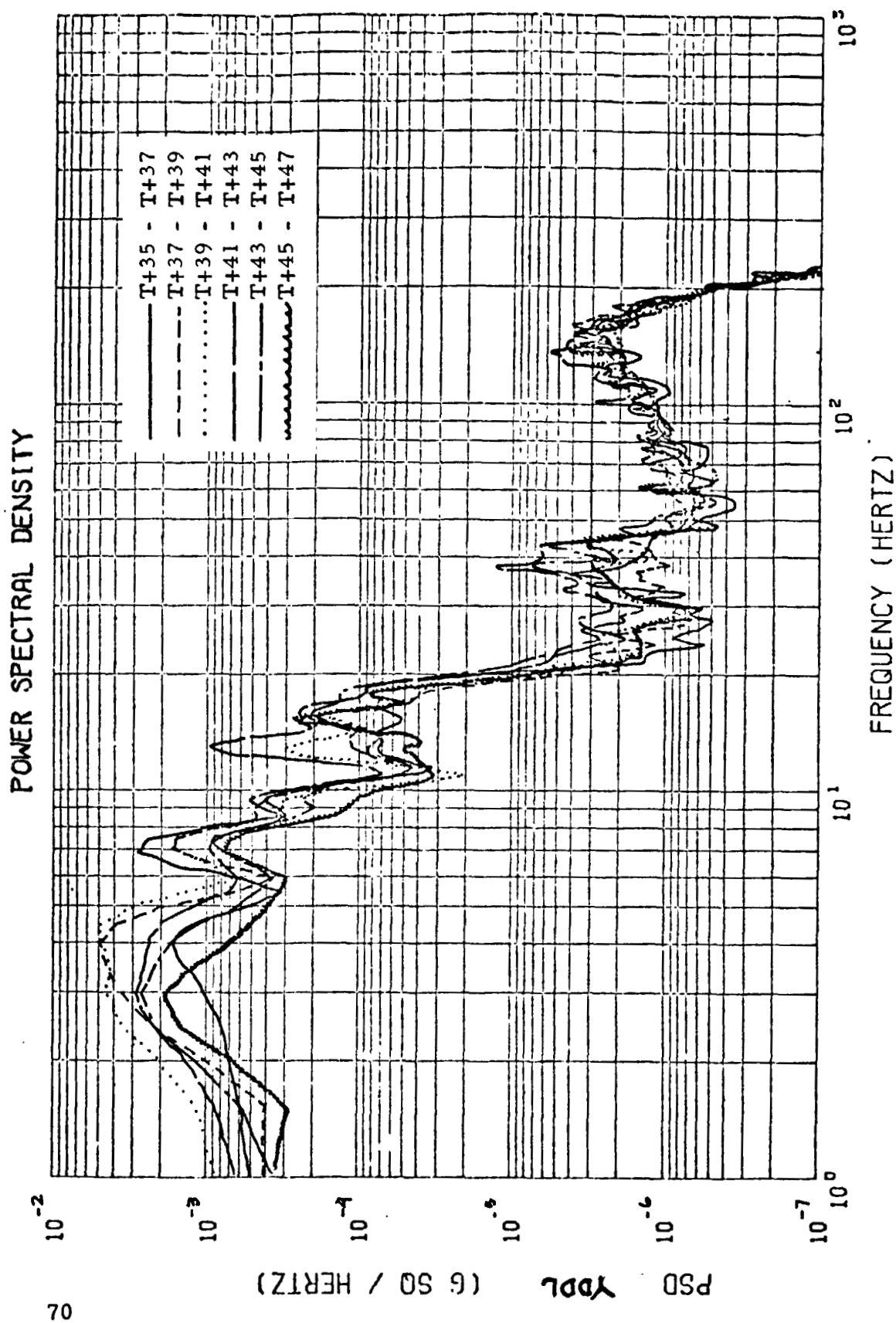


Figure 1.69 TC-3 Viking B Max Q Summary YDDL

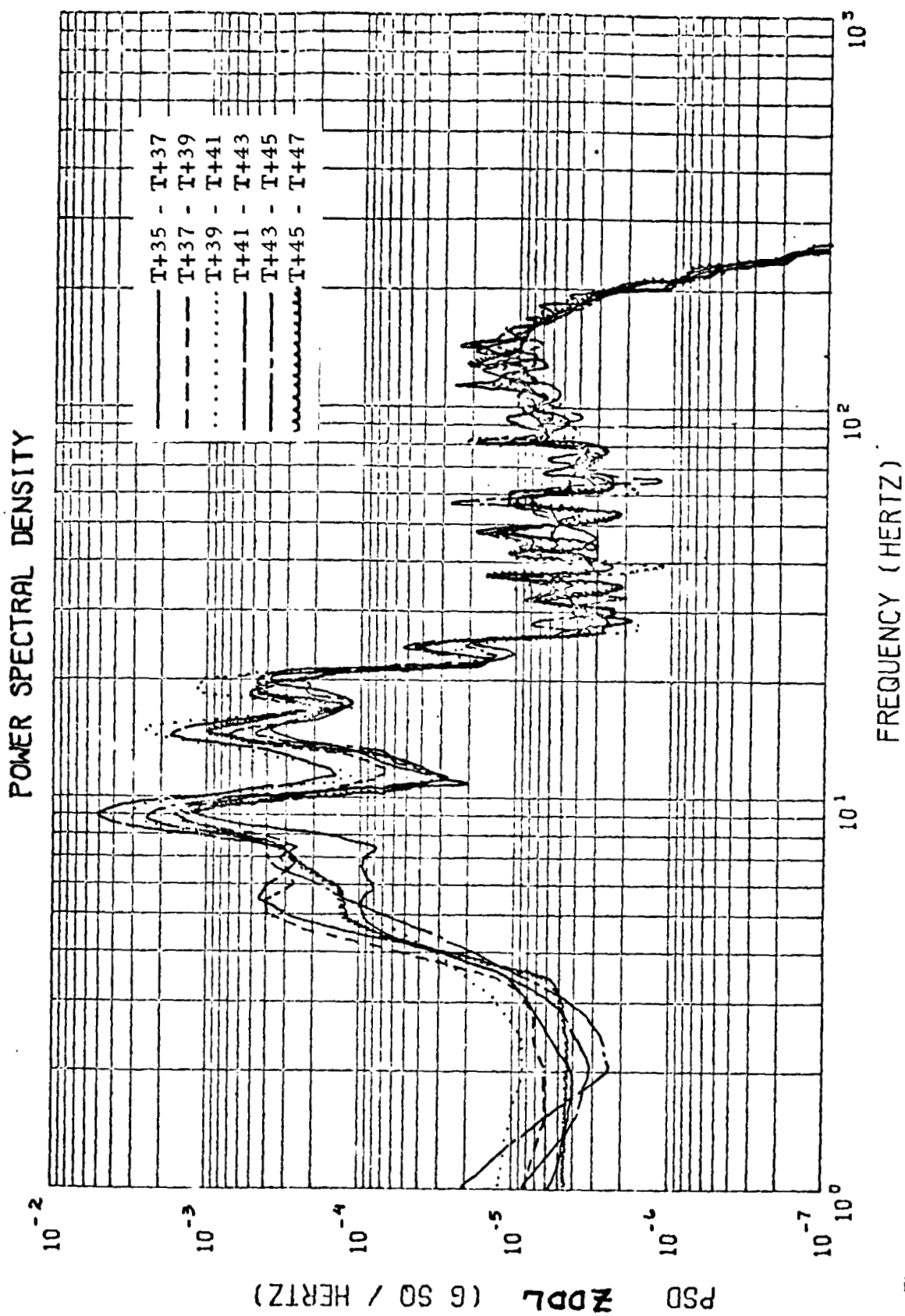


Figure 1.70 TC-3 Viking B Max Q Summary - ZDDL

POWER SPECTRAL DENSITY

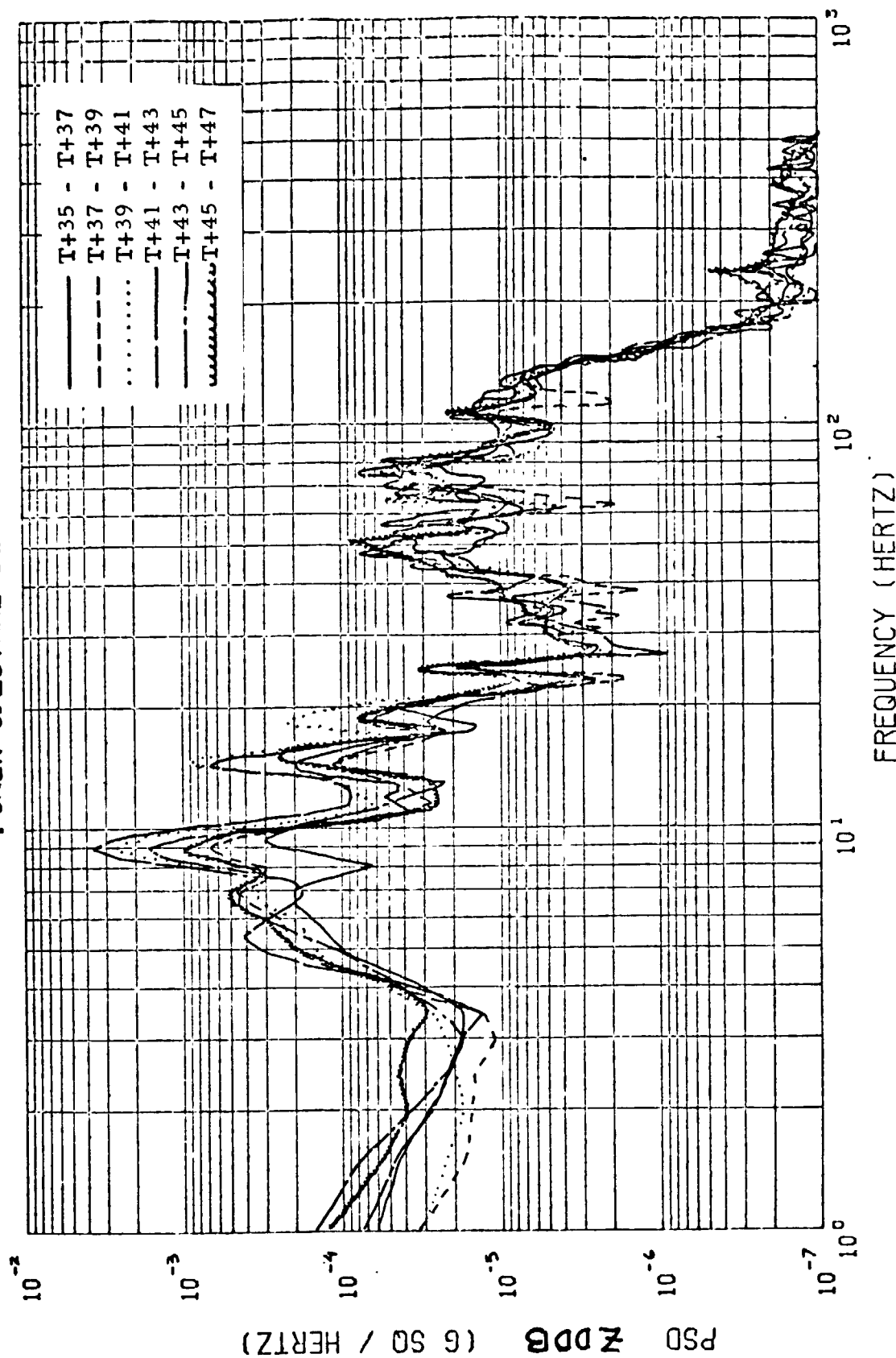


Figure 1.71 TC-3 Viking B Max Q Summary - ZDDB